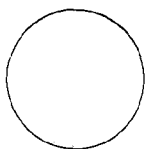


Guam: Coastal Zone Management Program

SURVEY AND SPECIES
INVENTORY OF REPRESENTATIVE
PRISTINE MARINE
COMMUNITIES ON GUAM

OCT 1977



COASTAL ZONE
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SURVEY AND SPECIES INVENTORY OF
REPRESENTATIVE PRISTINE MARINE
COMMUNITIES ON GUAM

By

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ABSTRACT

Development of coastal areas around Guam, whether it be commercial or private, is steadily on the increase. Early recognition of naturally diverse and stable areas is crucial for their subsequent protection as well as coordinated environmental usage.

Under the objectives of the Bureau of Planning, 305 Program, work request #500811-7-09, and the authority of the Coastal Zone Management Act of 1972, this survey was commissioned to assist in the designation of representative pristine marine areas to be protected from impacts of construction and development, but not to inhibit existing sport fishing and other recreational uses within controlled limits. These limits are to be set by the Bureau of Planning.

Pristine marine communities are defined as those areas that have retained or successfully reestablished their natural character, where natural character includes the biotic, and to a lesser extent abiotic, components of scientific, educational and aesthetic value.

Twelve pristine marine areas were chosen around the island representing such physiographic features as estuaries, fringing reefs, barrier reefs, patch reefs, barrier reef channels, fringing reef channels, mangrove swamps, seagrass beds, cut benches and submarine cliffs.

Selection criteria included the current GEPA water classification and number of point discharges for the area; those communities which due to their ecological character are of critical importance for scientific investigation and preservation of intact community structures; and finally those areas which may contain rare, unique or endangered species.

A brief description of the areas, their character, and the presence of endangered or threatened species is summarized. Species lists for fish, macroinvertebrates, corals and benthic algae, plus maps and field sketches are also included.

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INTRODUCTION

Guam, like any other growing area, and perhaps more so because of its island nature, must carefully regulate the use and development of its coastal areas. The effects of development by the U. S. military, private industry and more recently tourism and recreational home building have led to accelerated use and landscape alteration stresses. Even some of the more remote areas are beginning to feel such effects.

The value of protected marine areas cannot be overemphasized. They not only provide recreational, photographic and scientific exploration, but the presence of intact dynamic communities containing a diverse array of organisms, some of which may be uncommon or unique to Guam, are important indications of environmental stability. In addition to providing a buffering capacity against external disruptive forces (Odum, 1971), the diversity-stability relationship also increases the probability of some of the organisms possessing characteristics such as high specific sensitivity to certain discrete environmental changes. These organisms are known as "indicator species" and their reactions are often more sensitive than any scientific parameter. By comparative monitoring of protected marine reserves and already modified systems, then, it may be possible to detect the difference between minor, relatively insignificant changes and the major divergent trends indicative of serious environmental stress and degradation. See The Nature Conservancy (1975).

The purpose of this report is to provide preliminary data towards the recognition and establishment of pristine marine communities (natural area marine sanctuaries or areas of particular concern) on Guam under the objectives of the Coastal Management Section of the Bureau of Planning, 305 Program, work request #500811-7-09, by the authority of the Coastal Zone Management Act of 1972. This report is to assist in the designation of certain areas (of which the communities discussed are selected examples) to be protected from impacts of construction and development, but not to inhibit existing sport fishing and other recreational uses where applicable.

Scope of Work

Twelve representative pristine marine communities were selected around the island. Areas were covered seaward from the mean high tide water mark to approximately thirty meters depth. Selection criteria included:

- a. representatives of the specific areas known as:
 1. estuaries
 2. fringing reefs

3. barrier reefs
4. patch reefs
5. barrier reef channels
6. fringing reef channels
7. mangrove swamps
8. seagrass beds
9. cut benches
10. submarine cliffs

- b. current area usage with respect to the Guam Environmental Protection Agency (GEPA) water classification ratings and known point source discharges.
- c. those areas which due to their ecological character are of utmost importance for scientific investigation and preservation of intact communities as well as of unique and rare species and their critical habitats.
- d. those areas which (in accordance with "c" above) should be protected from such developments as heavy pollutant discharges, dredging, land fill, coral harvesting, etc.

Specific work items for the survey included the following for each area selected:

- a. species lists for marine plants (benthic algae and seagrasses), fishes, corals and macroinvertebrates.
- b. maps of each area showing the major physiographic features and locations of interesting and/or unique biotic habitats.
- c. a description of each area explaining the ecological significance and any special observations or findings.
- d. recognition of threatened or endangered species and their critical habitats. (See section on endangered and threatened species).
- e. recommendations of performance standards for the development and/or use of land and water adjacent to the described pristine areas.

The above items are presented in a systematic way, augmented by maps, tables and photographs for each selected area. The geographic size of each area is arbitrary at this time. Specific boundary areas are to be established by the Bureau of Planning at a later date.

The twelve selected areas are representative community types. Alternative or additional area candidates are suggested at the end of each individual section.

Figure 1 shows the selected pristine areas which are discussed separately in the subsequent sections.

Pristine Marine Community

In the strictest scientific sense there are probably no pristine marine communities on Guam, for the concept itself is one of ecologic perfection demanding the total absence of human activities and influences. Certainly, there are few places anywhere that can meet such stringent requirements. Casting aside the obvious points of definitional debate, however, there can be little argument as to the presence of many natural areas on Guam that have incurred minimal human impact and whose natural web of dynamic control systems have allowed them to remain stable and essentially unspoiled.

For purposes of this report, pristine marine community shall be defined as an area that has retained or successfully reestablished its natural character. Natural character includes the biotic, and to a lesser extent abiotic components of scientific, educational and aesthetic value. Of specific interest is the preservation of natural ecologic stability through diversity and to provide critical habitats for uncommon and possibly threatened or endangered species. Such selected representative areas need not be completely undisturbed but are those in need of protection against adjacent land or water use developments involving construction, pollutant discharge, dredging, filling, coral harvesting, commercial fishing, etc. Planned recreational use and sport fishing within tolerable environmental limits is to be retained where applicable.

Threatened and Endangered Species

The recognition and classification of threatened and endangered (formerly rare) marine species on Guam is an area of acute concern. The ambiguity of the 1973 Federal Endangered Species Act (Public Law 93-205) and its lack of specifically delineated selection criteria for such biota, has led to considerable confusion over which organisms should and should not be included. For this reason several preliminary efforts to identify candidate species by interested citizens and professionals alike, have met with marginal success at best.

At the present time there are no officially threatened or endangered species of algae, macroinvertebrates, fish or corals in the coastal marine waters of Guam.*

*Personal communications from H. T. Kami (Chief Biologist-Division of Aquatic and Wildlife Resources), R. H. Randall (Coral specialist-Marine Laboratory), Dr. L. G. Eldredge (Invertebrates-Marine Laboratory), Dr. R. T. Tsuda (Marine Plants-Marine Laboratory), and Dr. S. S. Amesbury (Fish-Marine Laboratory).

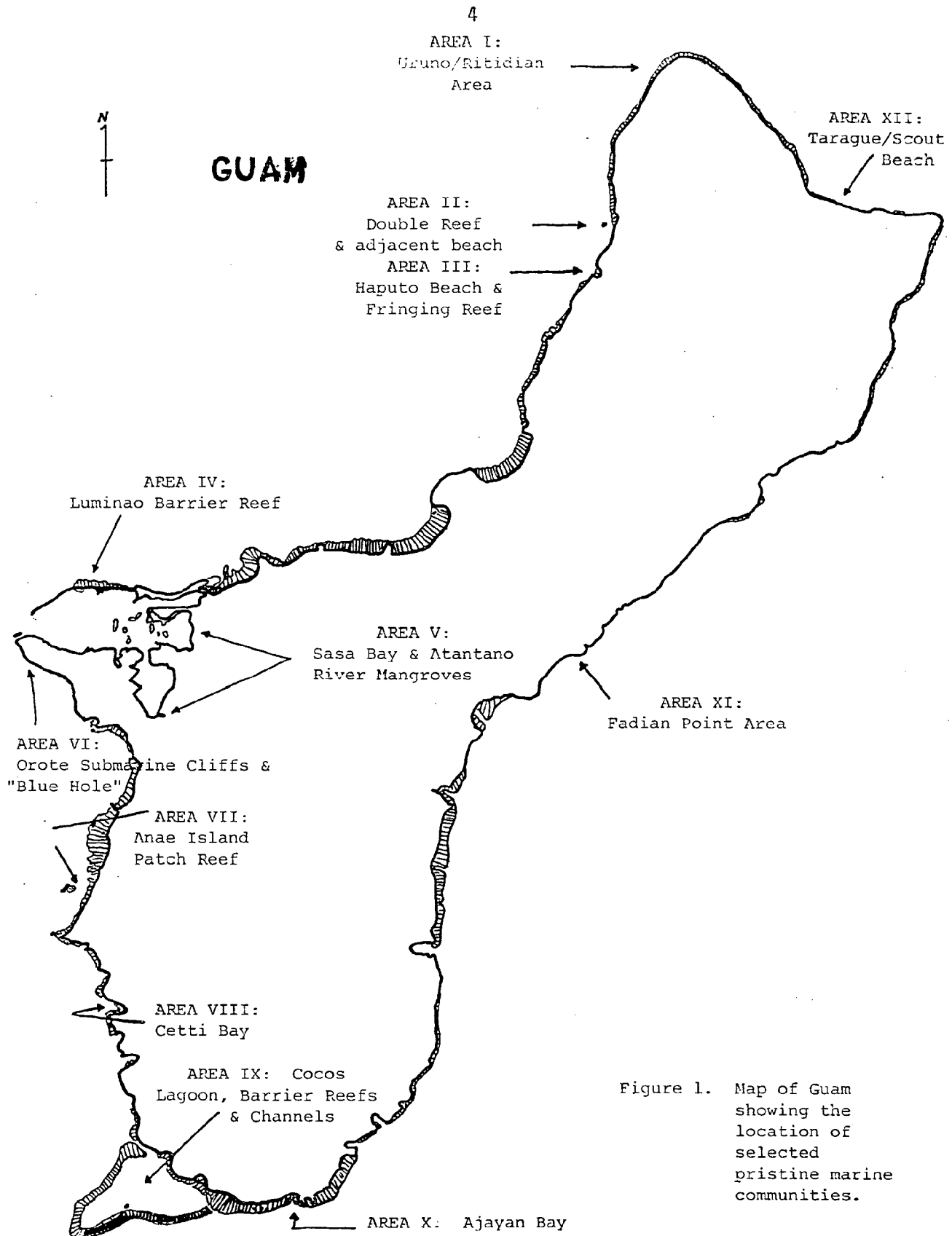


Figure 1. Map of Guam showing the location of selected pristine marine communities.

Larger pelagic (open ocean) organisms such as whales and turtles are already included in the Federal Register (U.S. Bureau of Sport Fisheries, 1973) and will not be discussed here. The fact that none are officially listed however, does not mean that such organisms do not exist, for undoubtedly they do. What it does mean is that systematic scientific investigation has not been conducted to realistically ascertain whether or not a species is genuinely threatened or endangered. The fact that a species has been seen in one locale does not justify its being classified as threatened or endangered since in most cases no one has searched for it elsewhere. Second, an uncommon organism on Guam may be found abundantly on other Micronesian islands. The range of organisms throughout Micronesia is not known.

In this report, threatened or endangered is used in a tentative sense only. Some of these organisms definitely need further investigation so that they may be nominated for official listing in the Federal Register. Table 1 lists those organisms thought to be threatened or endangered on Guam with pertinent information on location and status.

For additional information the reader is referred to O'Connor (1974) and Threatened Wildlife of the U. S., Resource Publication 114 (1973).

GEPA Water Quality Standards

The Guam Environmental Protection Agency (1975) recognizes two water quality classifications for the coastal marine waters of Guam (Fig. 2). These are:

Category "AA" = conservation

The uses to be protected in this category of waters are marine research, propagation of aquatic life (particularly coral reef organisms), conservation of wilderness areas, aesthetic enjoyment, and such recreational activities as do not impair the other established uses. This category of waters shall remain free from pollution attributable to domestic, commercial, and industrial discharges or agricultural, construction and other land-use practices that impair their protected use. . .

Category "A" = recreational

The uses to be protected in this category of waters are recreation (including swimming, surfing, skin and SCUBA diving, skiing, and other primary contact sports), aesthetic enjoyment, propagation of aquatic and associated wildlife, commercial, industrial and navigational uses.

Table 1. Coastal marine organisms thought to be rare (R) or uncommon (U) to Guam. Some of the listed organisms may be endangered or threatened species candidates for the Federal Register. These species are indicated with an asterick (*).

SPECIES	STATUS	REPORTED LOCATION
CORALS		
<u>Euphyllia</u> sp	R*	--
<u>Pachyclavularia violacea</u>	U	Orote submarine terrace
<u>Pavona frondifera</u>	U	Apra Harbor
<u>Pectinia lactuca</u>	U	Apra Harbor
<u>Plerogyra sinuosa</u>	R*	--
<u>Tubastraea aurea</u>	R*	Double Reef, Apra Harbor, Manell Channel
FISHES		
None		
ALGAE		
None		
MACROINVERTEBRATES		
ARTHROPODA		
<u>Birgus latro</u>	U	--
MOLLUSCA		
<u>Cassis cornuta</u>	U	--
<u>Charonia tritonus</u>	U	--
<u>Cypraea aurantium</u>	U	--
<u>Tridacna maxima</u>	U	--
CHORDATA		
<u>Chelonia mydas</u> (Green Turtle)	On Federal Register	variable
<u>Eretmochelys imbricata</u> (Hawksbill Turtle)	On Federal Register	variable
MANGROVE PLANTS		
<u>Barringtonia racemosa</u>	*	These organisms are locally abundant but their critical habitat is severely threatened. These plants could literally be lost overnight.
<u>Bruguiera gymnorhiza</u>	*	
<u>Lumnitzera littorea</u>	*	
<u>Rhizophora apiculata</u>	*	
<u>Rhizophora mucronata</u>	*	
<u>Xylocarpus moluccensis</u>	*	

The main distinction between the two classifications is the allowance of commercial, industrial and navigational uses in the latter. In both cases pollutant discharges are to be controlled to meet the specific requirements of each, the requirements being more rigorous in the "AA" category.

In the majority of the cases the selected pristine communities lie within the "AA" classification. Exceptions are noted. Figure 2 maps the categories for the island.

Background

No broad study has been made of representative pristine marine community types as outlined above for the express purpose of the eventual establishment of marine sanctuaries, although several detailed studies have been done on specific locales, usually in conjunction with other developmental projects.

The Guam National Seashore proposal of 1967 wished to set aside most of the southern end of the island including the coastal areas extending from Facpi Point to Ajayan Bay. The large area involved and the implications of controlling such an area were among the factors leading to its demise. Currently, a new proposal is under review which will set aside sanctuaries under a similar plan.

The single best overview of geology, hydrology and physiography of Guam's coastal regions can be found in Coastal Survey of Guam (Randall and Holloman, 1974). The report contains numerous maps, tables, photographs and an extensive review of the related literature, especially that of Emery (1962).

Basic coastal outlines and fringing reef contour maps including brief physiographic descriptions and the presence of seagrass beds can be found in the Atlas of Reefs and Beaches of Guam (Randall and Eldredge, 1976). This atlas served as a mapping base in this report.

The Preservation of Natural Diversity: A Survey and Recommendations (Nature Conservancy, 1975) presents an excellent overview and in-depth discussion of possible conservation approaches and their legal implications. Specific national and international examples of functioning sanctuaries systems are given. A full discussion of these factors is beyond the scope of this paper but interested persons are strongly encouraged to consult this report.

Biotic information and species lists were obtained from several sources plus additional field visits. Those technical reports, marine environmental surveys, miscellaneous reports and personal communiques are reviewed and referenced for each individual area and included at the end of each section.

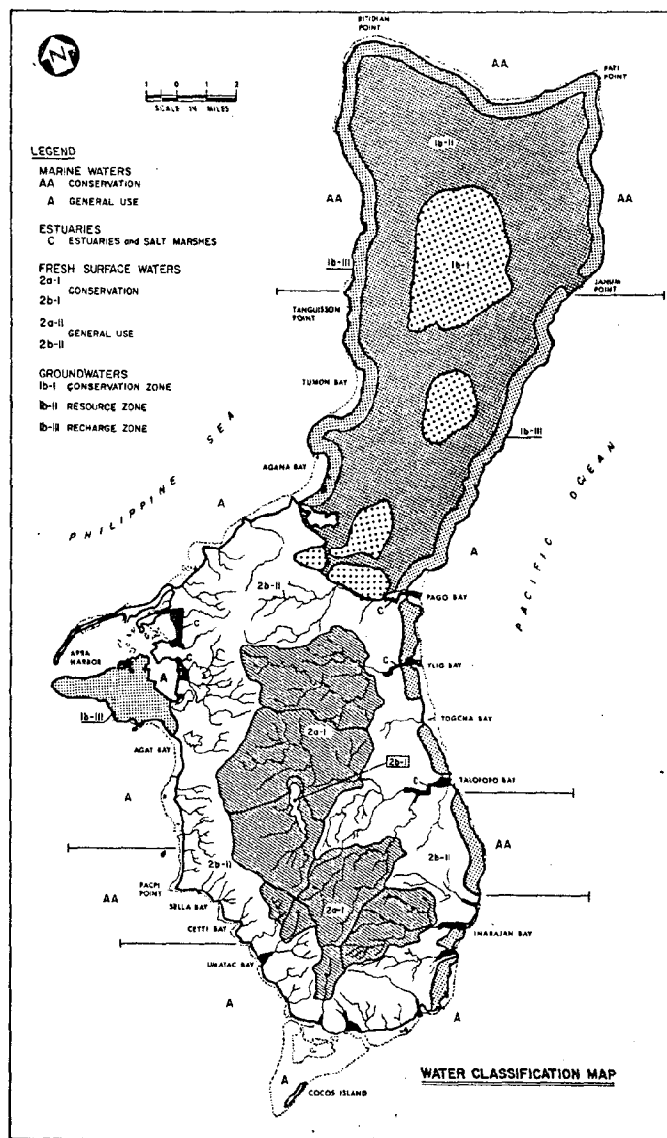


Figure 2. Guam Environmental Protection Agency water classification system. AA = conservation, A = recreational. (Courtesy GEPA)

METHODS

General study site information including both physiographic and biotic data was gleaned from the existing literature whenever possible. In most cases this proved insufficient and field visits were necessary. These consisted of single day reconnaissance trips to each area.

Field notes, sketches and photographs of reef detail were compiled and are shown on the maps for each area. All maps are 1:4800 scale unless otherwise specified using the Atlas of Reefs and Beaches of Guam (Randall and Eldredge, 1976) as a base. Reef and offshore details are included but are not to scale.

Information on species composition at each site was obtained by having all investigators snorkel or SCUBA through the area. Each person concentrated on a particular component, i.e., marine plants, fish, corals or macroinvertebrates, qualitatively noting the predominant species and/or any striking peculiarities of community size, diversity or distribution. Although six standard physiographic zones (intertidal, inner/outer reef flat, margin, margin face, submarine terrace and slope) are typically recognized, in many cases they have been "lumped together" biologically. This proved necessary based on available information and differing physical characteristics of each area.

It must be emphasized that no transects or other quantitative sampling methods were employed. No statistical inferences regarding abundance or density should be drawn from the species lists.

It is also noted that one day visits to an area necessarily preclude generation of a complete species list. This is particularly important with respect to transient individuals such as fish. Species lists for the Cocos area, Sasa Bay and the Uruno-Ritidian areas are fairly complete based on previous more extensive investigations. Obviously, no information is available for diurnal or seasonal biotic changes in species composition. The included lists are preliminary and cursory at best. Absence of common genera does not necessarily mean that they are not there but that they were not observed at the time of the study. Additions are expected and welcome.

AREA I:
URUNO-RITIDIAN AREA

The extreme northwestern coast of Guam extending from Falcona Beach north to Ritidian Point is the longest stretch of pristine beach on the island. The entire area lies within Andersen Air Force Base military reservation and, with the exception of a few private roads, the area is largely inaccessible to the public. Heavy swells and strong currents, especially near Ritidian, often make boat access hazardous as well.

A small section of reef flat between Ritidian Channel and Achae Point was selected (Fig. 3). The area was chosen because of its cuestasal algal ridge and reef flat platform development, typical of northwest Guam. The reef flat extending from Achae to Uruno is similar although a deeper moat has resulted in a more highly developed coral community in several places. For purposes of this report, the general community types are lumped together.

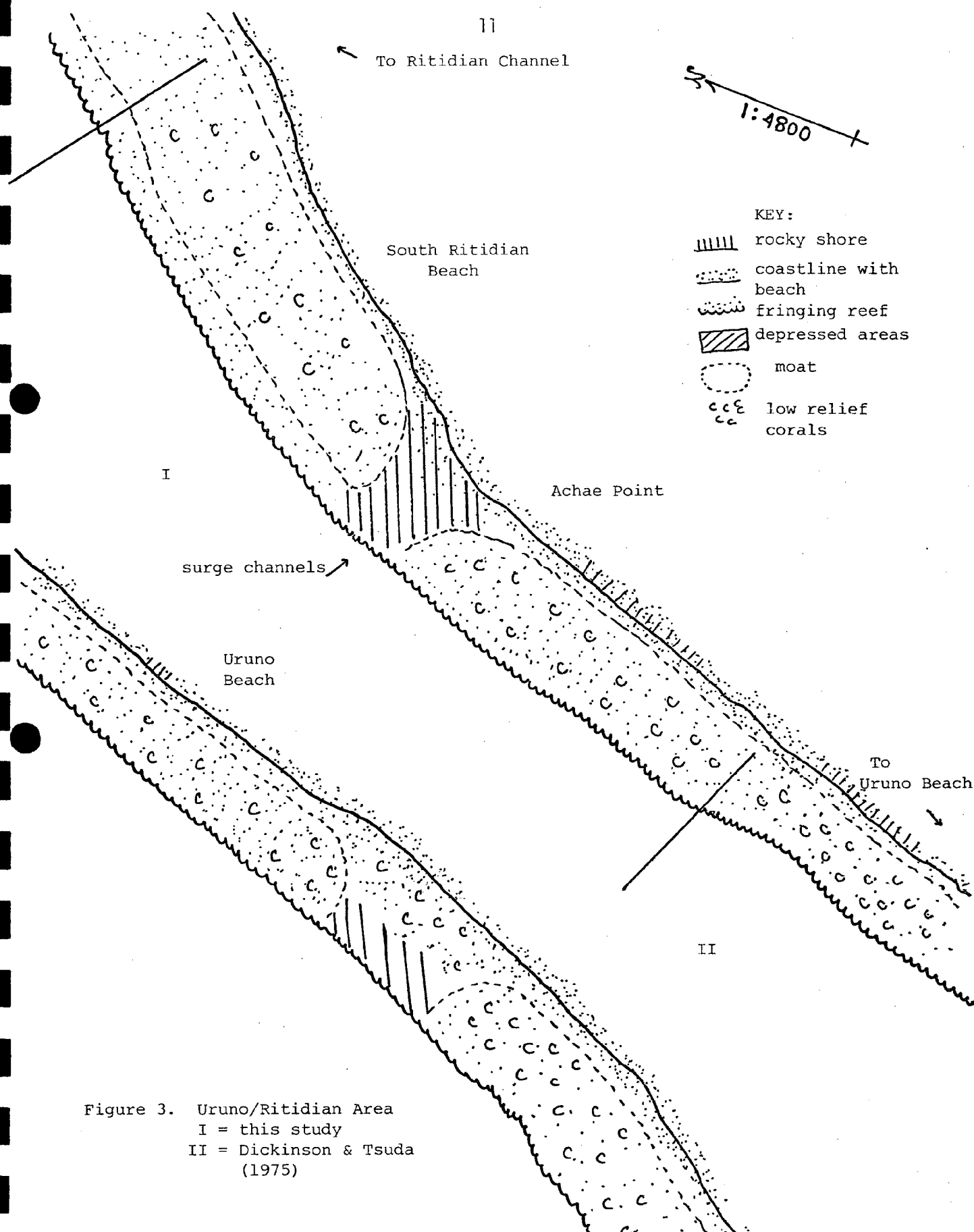
Two previous studies have been conducted in the area. Dickinson and Tsuda (1975) investigated the biological and environmental impact of resort development at Uruno. Their species lists have been used to augment these listings, (Tables 2-5). Randall and Holloman (1974) studied the geology, hydrology and physiography of this coastal sector. Portions of their physiographic description are incorporated here.

The Guam Environmental Protection Agency's water quality classification for this area is "AA", conservation. No point source discharges are known in this area (Shidel, 1977).

The study site was divided into three broad zones (Fig. 4); (1) the reef flat and associated moat, (2) reef margin and face with its cuestasal algal ridge, and (3) the submarine terrace and slope.

The sandy inner reef flat zone was only sparsely inhabited with the marked exception of Caulerpa antoensis, a small rhizoidal green alga able to tolerate constantly shifting sands. A shallow and well developed moat, ranging from 1-1.5 meters deep, extended out to the reef margin and algal ridge. Coral development in particular became progressively more luxurious, seaward towards the back side of the algal ridge. Small, low relief colonies gave way to larger thickets and colonies of Acropora and Porites. Goniastrea retiformis, Pocillopora damicornis, Psammocora contigua and Millepora species were also abundant. Towards Uruno, higher relief colonies were more common.

The moat and outer reef platform contained a rich composition of both turf and fleshy algae. Chlorodesmis, Halimeda, Caulerpa,



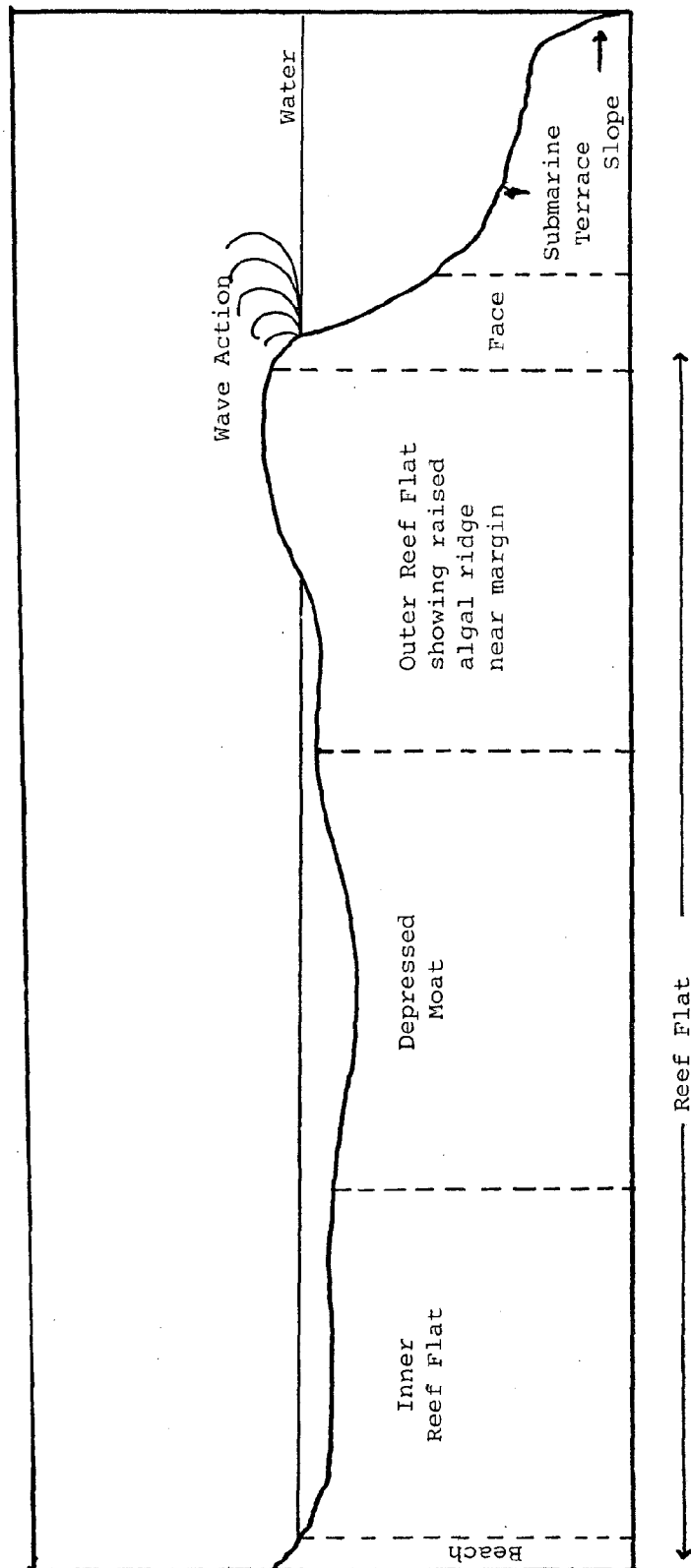


Figure 4. Generalized profile of major reef divisions along the northwest coast of Guam.

Boodlea, Turbinaria and Gelidium species were visually dominant though many species were observed.

A wide and colorful variety of fish were observed in the moat area. Chaetodontids, pomacentrids, acanthurids and balistids were abundant. These are among the most beautiful reef fishes.

Dominant macroinvertebrates in this zone included the sea cucumbers Holothuria atra and Stichopus chloronotus, and the blue starfish Linckia laviegata.

The second zone was characterized by a cuetal algal ridge. The Uruno-Ritidian area is a good representative of this type of margin development. The ridge is typically above the high water line and continuously wave washed. A thick orange mat of the red alga Gelidiella acerosa covers the entire ridge. The coralline alga Porolithon onkodes was also dominate though less conspicuous. Small Pocillopora colonies were found in a few sheltered crevices.

The third zone consisted of a terrace 5-10 meters in width which abruptly dropped to approximately 15 meters. Scoured surge channels up to 8 meters wide cut through the reef platform in several places allowing free access between the reef platform and terrace.

Coral cover was moderate to sparce in this zone due to heavy Acanthaster planci predation in the late sixties (Chesher, 1969). Recolonization is evident but a low relief is still maintained. The encrusting coral Montipora is quite common in several different colors. Favia, Platygyra, Porites and Pocillopora species were also common.

Algal cover was rich with the larger forms prevalent. Halymenia, Galaxaura and Halimeda species dominated.

The radical topography, holes, overhangs and crevices present in the terrace and slope zones have created numerous habitats for fish and invertebrates. Acanthurids, blennies, pomacentrids and labrids were abundant. Larger game fish and grey sharks are known to inhabit the area though none were seen.

The Federally endangered Hawksbill turtle (Eretmochelys imbricata) has been seen in this area in the deeper slope waters. This is probably a transient condition. No other threatened or endangered species are known for this area.

CONCLUSIONS AND RECOMMENDATIONS

The coastline extending from Uruno Point to Ritidian, a distance of approximately 1.9 kilometers is one of the most pristine stretches of beach and reefs on Guam. The size of this area necessarily pre-

cluded its entire consideration in this report. However, it is strongly recommended that the entire coastal sector be made a reserve if possible. Any section of this strip could serve as an alternative site.

The presence of many beautiful corals and fish on both the reef flat platform and terrace areas, combined with an abundance of game fish, striking topography and clear water, make this area a strong preservation candidate.

The following recommendations are suggested:

- 1) that this area be established as a natural marine sanctuary in which no coral harvesting, net fishing or other such activity be permitted.
- 2) because of heavy swells and strong currents, recreational development is probably not a viable alternative without major developmental modification (Dickinson and Tsuda, 1975).

Table 2. Checklist of benthic algae observed at the Uruno/Ritidian study site. * = observed by Dickinson and Tsuda (1975).

SPECIES	ZONES		
	1	2	3
CYANOPHYTA (blue-green algae)			
<u>Microcoleus lyngbyaceus</u>	x	x	x
<u>Schizothrix calcicola</u>	x	x	x
<u>S. mexicana</u>	x	x	x
CHLOROPHYTA (green algae)			
<u>Boergesenia forbesii</u>	x		
<u>Boodlea composita</u>	x		
<u>Caulerpa antoensis</u>	xx		
<u>C. racemosa</u>	x	x	
* <u>C. serrulata</u>	x	x	
<u>Chlorodesmis fastigiata</u>	x	x	
* <u>Cladophoropsis membranacea</u>	x		
* <u>Dictyosphaeria cavernosa</u>	x		
<u>D. versluysii</u>	x		
* <u>Enteromorpha clathrata</u>			x
* <u>Halimeda copiosa</u>		x	x
* <u>H. discoidea</u>		x	x
<u>H. incrassata</u>		x	x
<u>H. opuntia</u>	x	x	x
<u>H. velasquezii</u>	x		x
* <u>Microdictyon okamurai</u>	x	x	
<u>Neomeris annulata</u>	x	x	x
* <u>Neomeris vanbosseae</u>	x	x	x
* <u>Valonia aegagropila</u>	x		
<u>Valonia ventricosa</u>	x	x	
* <u>Valoniopsis pachynema</u>	x		
PHAEOPHYTA (brown algae)			
<u>Dictyota bartayresii</u>	x		
<u>D. friabilis</u>		x	x
* <u>Feldmannia indica</u>	x		x
<u>Lobophora variegata</u>	x	x	x
<u>Padina jonesii</u>		x	x
<u>P. minor</u>	x		
* <u>Ralfsia pangoensis</u>	x		
<u>Sargassum cristaefolium</u>		x	
* <u>Sphacelaria tribuloides</u>		x	x
<u>Turbinaria ornata</u>	x	x	

Table 2. (continued)

SPECIES	ZONES		
	1	2	3
RHODOPHYTA (red algae)			
<u>Actinotrichia fragilis</u>		x	
<u>Amphiroa fragilissima</u>	x	x	
* <u>Champia parvula</u>	x		
* <u>Chondria</u> sp.	x		
* <u>Dasyphila plumarioides</u>		x	
<u>Desmia hornemanni</u>		x	
* <u>Galaxaura filamentosa</u>	x		
<u>G. marginata</u>	x	x	
<u>G. oblongata</u>	x	x	
<u>Gelidiella acerosa</u>	x	xx	
<u>Gelidiopsis intricata</u>	x	x	
<u>Gelidium pusillum</u>	x	x	
<u>Gelidium</u> sp.		x	x
* <u>Hypnea cervicornis</u>		x	
<u>Jania capillacea</u>	x	x	x
* <u>Leveillea jungermannioides</u>		x	
<u>Liagora</u> sp.		x	
<u>Polysiphonia</u> sp.	x	x	x

Table 3. Checklist of corals observed at the Uruno/Ritidian study site. * = observed by Dickinson and Tsuda (1975).

SPECIES	ZONES	
	1	2
ANTHOZOA		
THAMNASTERIIDAE		
<u>Psammocora contigua</u>	x	x
POCILLOPORIDAE		
<u>Styolphora mordax</u>	x	
<u>Pocillopora damicornis</u>	x	
<u>P. elegans</u>	x	
<u>P. setchelli</u>	x	
* <u>P. verrucosa</u>		x
ACROPORIDAE		
* <u>Acropora abrotanoides</u>		x
<u>A. aspera</u>	x	
<u>A. hebes</u>	x	
* <u>A. irregularis</u>	x	x
<u>A. nasuta</u>		x
<u>A. squarrosa</u>	x	
* <u>A. tubicinaria</u>	x	
* <u>Astreopora listeri</u>		x
* <u>A. myriophthalma</u>		x
* <u>Montipora conicua</u>		x
<u>M. ehrenbergii</u>		x
* <u>M. floweri</u>		x
* <u>M. tuberculosa</u>		x
* <u>M. verrucosa</u>		x
AGARICIIDAE		
* <u>Pavona clavus</u>		x
* <u>P. varians</u>	x	
FUNGIIDAE		
<u>Fungia fungities</u>		x
PORITIDAE		
* <u>Porites lichen</u>		x
<u>P. lutea</u>	x	x

Table 3. (continued)

SPECIES	ZONES	
	1	2
FAVIIDAE		
<u>Favia pallida</u>		x
* <u>F. stelligera</u>		x
<u>Favites virens</u>		
* <u>Oulophyllia crispa</u>	x	
<u>Plesiastrea</u> sp.		x
* <u>Goniastrea pectinata</u>		x
<u>G. retiformis</u>		x
<u>Platygyra rustica</u>		x
<u>P. sinensis</u>		x
* <u>Leptoria phrygia</u>		x
<u>L. sp.</u>		x
<u>Leptastrea purpurea</u>		x
<u>Cyphastrea chalcidicum</u>		x
* <u>C. serailia</u>		x
MUSSIDAE		
<u>Acanthastrea echinata</u>		x
HELIOPORIDAE		
<u>Heliopora coerulea</u>		x
ALCYONIIDAE		
<u>Lobophytum crebriplacatum</u>	x	x
<u>Sinularia densa</u>	x	x
NEPHTHEIDAE		
<u>Stereonephthya</u> sp.		x
HYDROZOA		
MILLEPORIDAE		
<u>Millepora dichotoma</u>	x	
<u>M. exaesa</u>		x
<u>M. platyphylla</u>		x

Table 4. Checklist of common macroinvertebrates observed at the Uruno/Ritidian study site. * = observed by Dickinson and Tsuda (1975).

SPECIES	ZONES		
	1	2	3
PORIFERA			
<u>Cinachyra australiensis</u>	x		
MOLLUSCA			
GASTROPODA			
<u>Astrea rhodostoma</u>	x		
* <u>Conus chaldaeus</u>	x		
* <u>C. ebraeus</u>	x		
* <u>C. miles</u>	x		
* <u>C. miliaris</u>	x		
* <u>C. sponsalis</u>	x		
* <u>Cymatium poleare</u>	x		
* <u>Cypraea meneta</u>	x		
* <u>C. tigris</u>	x		
<u>Drupa clathrata</u>	x		
<u>D. morum</u>	x		
<u>D. ricinus</u>	x		
* <u>Lambis</u> sp.	x		
* <u>Latirus</u> sp.	x		
<u>Thais armigera</u>	x		
* <u>T. tuberosa</u>	x		
* <u>Nerita plicata</u>	x		
<u>Trochus niloticus</u>	x		
* <u>Turbo argyrostoma</u>	x		
* <u>Vasum ceramicum</u>	x		
<u>V. turbinellus</u>	x		
BIVALVIA			
<u>Tridacna maxima</u>	x		
ECHINODERMATA			
ASTEROIDEA			
* <u>Choriaster granulatus</u>	x		
* <u>Culcita novaeguineae</u>	x		
<u>Linckia laevigata</u>	x		
<u>L. multiflora</u>	x		
<u>L. pacifica</u>	x		

Table 4. (continued)

SPECIES	ZONES		
	1	2	3
ECHINOIDEA			
<u>*Echinometra mathaei</u>	x		
<u>Echinostrephus aciculatus</u>	x		
<u>Echinothrix diadema</u>	x		
HOLOTHUROIDEA			
<u>Actinopyga echinites</u>	x		
<u>Bohadschia argus</u>	x		
<u>B. bivittata</u>	x		
<u>Holothuria atra</u>	x		
<u>*H. cinerascens</u>	x		
<u>*H. difficilis</u>	x		
<u>*H. hilla</u>	x		
<u>H. nobilis</u>	x		
<u>Stichopus chloronotus</u>	x		
ARTHROPODA			
CRUSTACEA			
<u>Calcinus gaimardi</u>	x		
<u>Dardanus guttatus</u>	x		

Table 5. Checklist of fishes observed at the Uruno/Ritidian study site. * = observed by Dickinson and Tsuda (1975).

SPECIES	ZONES		
	1	2	3
ACANTHURIDAE			
<u>Acanthurus glaucopareius</u>	x		
<u>A. guttatus</u>	x	x	
<u>A. lineatus</u>	x	x	
<u>A. nigrofusus</u>	x		
* <u>A. olivaceus</u>	x		
<u>A. triostegus</u>	x		
<u>Ctenochaetus striatus</u>	x		
<u>Naso lituratus</u>	x		
APOGONIDAE			
* <u>Cheilodipterus quinquelineata</u>	x		
BALISTIDAE			
<u>Balistapus undulatus</u>	x		
<u>Balistes chrysopterus</u>	x		
<u>Melichthys vidua</u>	x		
* <u>Rhinecanthus rectangulus</u>	x	x	
BLENNIIDAE			
<u>Cirripectes variolosus</u>		x	x
<u>C. sp.</u>		x	x
<u>Plagiotremus tapeinosoma</u>	x		
BLOTHIDAE			
*"Bothid sp."			
CANTHIGASTERIDAE			
<u>Canthigaster solandri</u>	x		
CARCHARHINIDAE			
<u>Carcharhinus melanopterus</u>			x
<u>C. menisorrh</u>			x
CHAETODONTIDAE			
* <u>Centropyge flavissimus</u>	x		

Table 5. (continued)

SPECIES	ZONES		
	1	2	3
<u>*Chaetodon auriga</u>	x		
<u>C. citrinellus</u>	x		
<u>C. ephippium</u>	x		
<u>C. ornatissimus</u>	x		
<u>C. quadrimaculatus</u>	x		
<u>*Megaprotodon strigangulus (=C. trifascialis)</u>	x		
<u>Pomacanthus imperator</u>	x		
CIRRHITIDAE			
<u>Cirrhitus pinnulatus</u>	x	x	
<u>Paracirrhitus forsteri</u>	x		
<u>P. hemistictus</u>		x	x
FISTULARIIDAE			
<u>Fistularia sp.</u>	x		
GOBIIDAE			
<u>*Eleotrides strigatus</u>	x	x	
<u>Ptereleotris tricolor</u>	x		
HOLOCENTRIDAE			
<u>*Adioryx sp.</u>	x		
LABRIDAE			
<u>Anampses caeruleopunctatus</u>	x		
<u>*Cirrhilabrus sp.</u>	x		
<u>Cheilinus rhodochrous</u>	x		
<u>C. trilobatus</u>	x		
<u>Gomphosus varius</u>	x		
<u>Halichoeres hortulanus (=H. centiquadrus)</u>	x	x	
<u>*H. marginatus</u>	x	x	
<u>*H. trimaculatus</u>	x	x	x
<u>*Hemigymnus fasciatus</u>		x	
<u>*H. melapterus</u>		x	
<u>Labroides dimidiatus</u>	x	x	
<u>Macropharyngodon pardalis</u>	x		
<u>*Stethojulis axillaris</u>	x	x	
<u>S. bandanensis</u>	x		
<u>Thalassoma fuscum</u>		x	x
<u>*T. hardwickei</u>		x	

Table 5. (continued)

SPECIES	ZONES		
	1	2	3
<u>T. purpureum</u>		x	x
<u>T. quinquevittata</u>		x	
LUTJANIDAE			
<u>Caesio</u> sp.	x		
<u>Lutjanus monostigmus</u>		x	x
<u>Lutjanus</u> sp.			x
* <u>Scolopsis cancellatus</u>		x	
MONACANTHIDAE			
<u>Amanses</u> sp.	x		
MUGILOIDIDAE			
* <u>Parapercis cephalopunctatus</u>		x	
MULLIDAE			
* <u>Mulloidichthys auriflamma</u>		x	
* <u>M. samoensis</u>		x	
<u>Parupeneus bifasciatus</u>	x		
<u>P. cyclostomus</u>		x	
<u>P. multifasciatus</u>	x	x	
<u>P. pleurostigma</u>		x	
POMACENTRIDAE			
* <u>Abudefduf amabilis (=Glyphidodontops leucopomus)</u>	x		
* <u>A. dicki (=Plectroglyphidodon dickii)</u>	x		
* <u>A. glaucus (=Glyphidodontops glaucus)</u>	x		
* <u>A. leucopomus (=Glyphidodontops leucopomus)</u>	x		
* <u>A. leucozona (=Glyphidodontops leucozona)</u>	x		
* <u>A. septemfasciatus</u>	x		
* <u>A. sordidus</u>	x		
* <u>Chromis caeruleas</u>	x		
* <u>Dascyllus aruanus</u>	x		
<u>Glyphidodontops leucopomus</u>		x	x
<u>Plectroglyphidodon dickii</u>	x		
<u>P. imparipennis</u>	x		
<u>P. leucozona</u>		x	x
<u>P. phoenixensis</u>			x
* <u>Pomacentrus amboinensis</u>	x		

Table 5. (continued)

SPECIES	ZONES		
	1	2	3
* <u>P. nigricans</u> (=Eupomacentrus nigricans)	x		
* <u>P. vaiuli</u>	x	x	
SCARIDAE			
<u>Scarus sordidus</u>	x		
<u>S. sp.</u>	x		
<u>Xanothon margaritus</u>		x	
SERRANIDAE			
<u>Epinephelus</u> sp.	x		
TETRAODONTIDAE			
* <u>Arothron hispidus</u>		x	
TRIAKIDAE			
<u>Triaenodon obesus</u>		x	
ZANCLIDAE			
<u>Zanclus cornutus</u>	x		

AREA II:
DOUBLE REEF

Located on the northwest coast of Guam, between Falcona Beach and Pugu Point, Double Reef consists of a narrow fringing reef and an adjacent patch reef, approximately 350 meters off shore (Fig. 5). The surrounding land is part of the U. S. Naval Communications Finegayan Military Reservation and the Federal Aviation Administration. Calm seas and good anchorage make water access possible throughout most of the year. No land access is possible. Clear water and changing topography, combined with two highly diversified reef communities, make Double Reef an excellent representative pristine marine area.

No previous survey has been done for the Double Reef area with respect to the marine biotic community. A partial physiographic description of the area is given by Randall and Holloman (1974). The following summary is taken in part from their report.

Double Reef is a small oval patch reef measuring approximately 300 meters in diameter. The upper surface of the reef is typically wave-washed and occasionally exposed during low spring tides. An adjacent developmental reef front and submarine terrace zone extend both northwest and shoreward to the fringing reef platform. A sandy channel floor lies south of the patch reef. Many holes, and coral ridges with equivalent reliefs of 20-50 feet (6 - 15 meters) are located shoreward on the submarine terrace. The range of topography and its beauty make Double Reef a favorite recreational spot for SCUBA diving, fishing and photography.

The Guam Environmental Protection Agency water rating for the Double Reef area is "AA" - conservation. No point source discharges are known in the area (Shidel, 1977).

Two visits were made to the Double Reef area. For purposes of this discussion the study area was divided into four zones: (1) the inner reef flat, (2) outer reef flat and margin face, (3) submarine terrace with its massive coral ridges and sand channels and (4) the patch reef. Tables 6 through 9 list the various species observed in the four zones.

Zone 1, the inner reef flat platform, consisted of a narrow, poorly developed, sand covered limestone pavement. Freshwater springs were abundant. The green alga, Enteromorpha clathrata and the invertebrate Holothuria atra were the only organisms observed. Most of the platform is exposed at low tide.

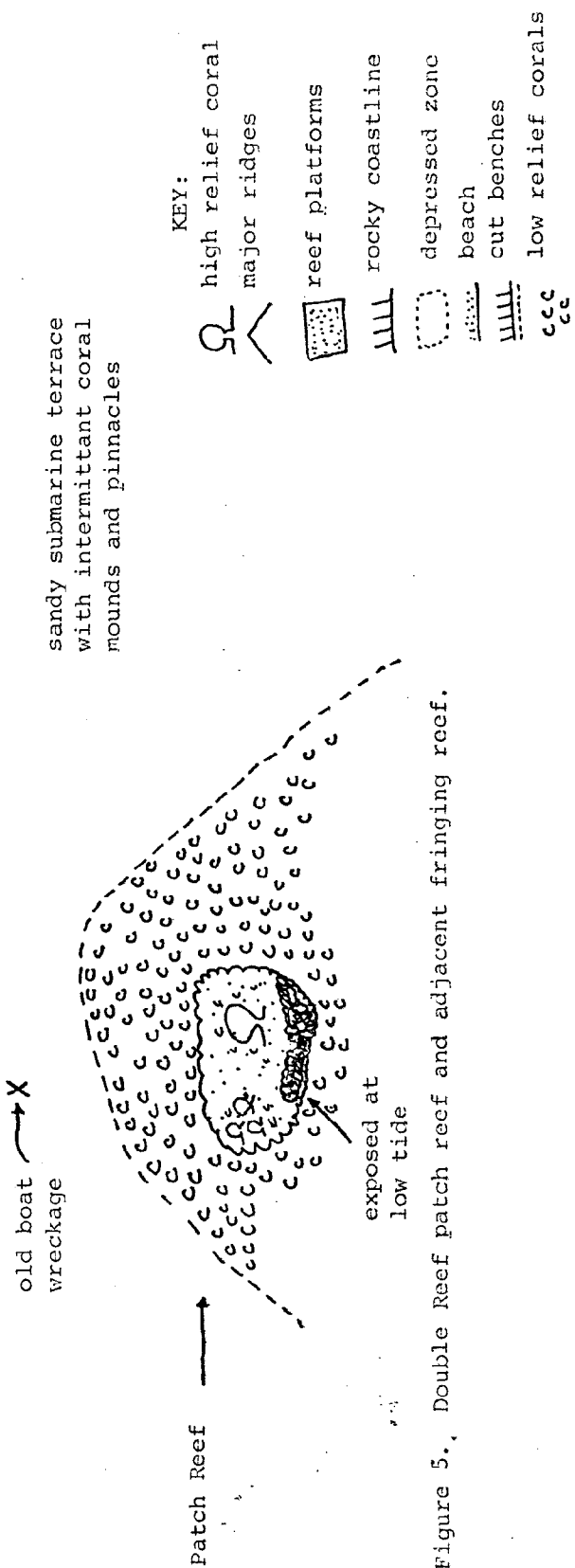
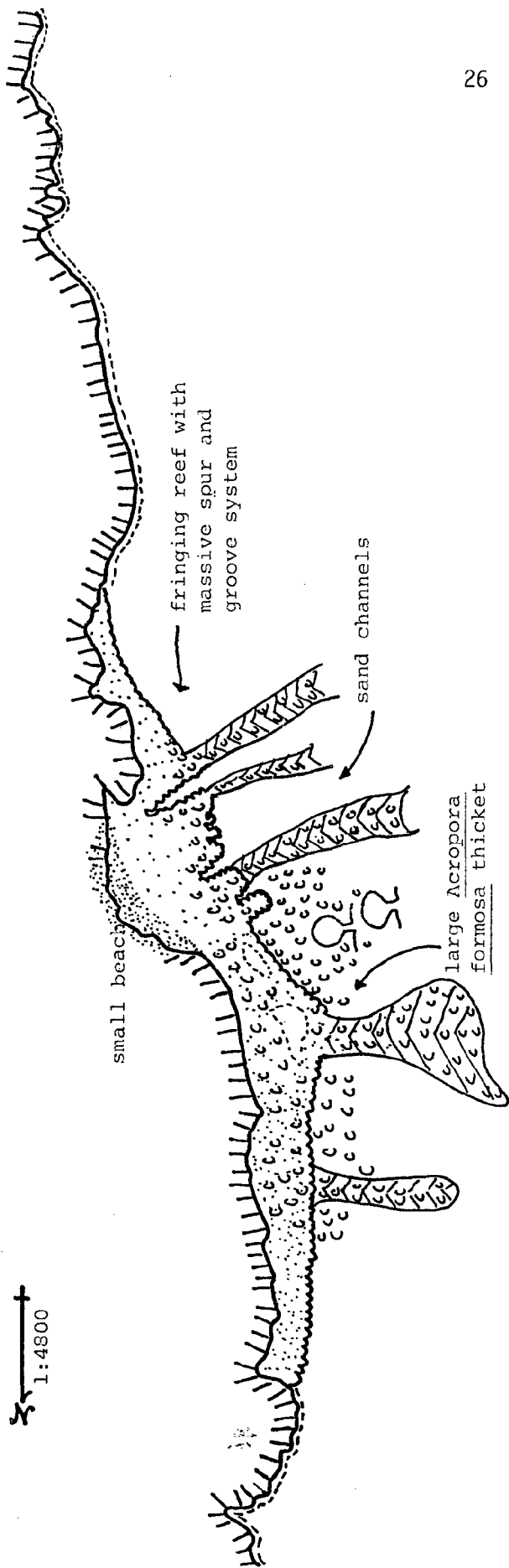


Figure 5. Double Reef patch reef and adjacent fringing reef.

The outer reef flat and margin face (Zone 2) were characterized by a porous substratum riddled with small channels, indentations and holes, some measuring 8-10 meters in depth. In several places grooves were overgrown at the top by calcareous algae and coral, forming semi-enclosed overhangs which formed a triangle in cross-section. Holes in the ceiling structure admit light, creating spectacular and well protected habitats for a wide variety of organisms, especially fish. This honeycombed reef structure was similar to that found at Haputo Reef approximately one mile south.

Coral coverage was high and remarkably diverse for northwestern Guam. In general, colonies tended to be of low relief and of the encrusting type. Many attractively branched and colorful Pocillopora and Acropora species were noted.

The honeycombed reef structure has resulted in a highly diversified and exceedingly rich ichthyofauna. Twenty-four families representing 108 species were identified for the three combined areas. With more observations this could be increased by 25-30 percent. Chaetodontids and pomacentrids were visually dominant.

Algal cover was rich and diverse. Both turf and fleshy algae were well represented. Gelidium, Ceramium and Polysiphonia species along with Halimeda, Chlorodesmis, Dictyota, Galaxaura, Mastophora and Amphiroa species dominated. Of special importance were the crustose and coralline red algae. Mesophyllum, Lithophyllum, Lithoporella and Corallina species were abundant though less impressive than those specimens observed at Haputo.

Macroinvertebrates seemed to be fairly evenly dispersed. The blue starfish Linckia laviegate and the holothurion Stichopus chloronotus were common. The "crown-of-thorns" starfish, Acanthaster planci was only observed twice. See Table 8.

The submarine terrace (Zone 3) was characterized by massive coral ridges. This physiographic feature was not well developed at Haputo. The ridges rise at angles of 45 degrees or more from wide sand channel floors to within 3 meters of the surface. Many were 10 meters or more in height and 100-120 meters long, gradually tapering off with the terrace floor.

Because of the widely variable relief in this zone, considerable differences in community structure were apparent. The massive coral ridges were virtually covered by small Pocillopora and Acropora colonies with a variety of other genera interspersed. In several places massive Porites and Acropora mounds and pillars added to the relief. Directly opposite the patch reef, two extensive thickets of the staghorn coral, Acropora formosa, extended from the reef margin to the terrace.

Much of this zone, notably south of the patch reef, consisted of sand floors with little vegetation. In one area the wreckage of an old boat has created an artificial reef for many colorful corals and fishes.

The diversity of marine plants was somewhat less than that observed in Zone 2. Chlorodesmis, Halimeda, Galaxaura, Desmia and Turbinaria species were visually dominant in addition to many turf algal species. Particularly striking was the fleshy red alga, Halymenia durvillaei. Some of the bushy thalli were one meter tall.

The patch reef (Zone 4) consisted of reef-rock pavement with local patches of sand, rubble and scattered coral/algal communities. The extreme western side of the patch reef is almost continuously wave washed. The turf alga, Gelidiella acerosa, and the fleshy algae, Halimeda, Dictyota and Galaxaura species were conspicuous, although many other genera were also present in abundance.

CONCLUSIONS AND RECOMMENDATIONS

The Double Reef area represents a rich and diverse pristine marine community. The "rare to Guam" coral, Tubastraea aurea, has been reported by Randall in this area. No threatened or endangered species have been identified specifically for this area, although it is important to realize that the fragile nature of any pristine community is such that anything short of preservation and controlled recreational use could result in a large number of species being locally threatened in a short time.

The following recommendations are suggested for the Double Reef area:

- 1) that this area be established as a natural sanctuary in which no coral harvesting, fishing or other such activity be allowed.
- 2) that swimming, snorkeling and SCUBA diving activities should be retained.
- 3) that a "Thermos Law" be enforced to halt beverage can litter.

Table 6. Checklist of benthic algae observed at Double Reef.

SPECIES	ZONES			
	1	2	3	4
CYANOPHYTA (blue-green algae)				
<u>Microcoleus lyngbyaceus</u>	x	x	x	x
<u>Schizothrix calcicola</u>		x		x
<u>Schizothrix mexicana</u>		x	x	x
CHLOROPHYTA (green algae)				
<u>Boergesenia forbesii</u>		x		
<u>Bryopsis pennata</u>		x		x
<u>Boodlea composita</u>		x		
<u>Caulerpa racemosa</u>		x	x	x
<u>C. serrulata</u>		x	x	x
<u>Chlorodesmis fastigiata</u>		x	x	x
<u>Codium edule</u>		x		
<u>Dictyosphaeria versluysii</u>		x		x
<u>Enteromorpha clathrata</u>	x			
<u>Halimeda macroloba</u>			x	x
<u>H. opuntia</u>		x	x	x
<u>H. velasquezii</u>		x		x
<u>Neomeris annulata</u>		x	x	x
<u>Rhipilia orientalis</u>		x		
<u>Tydemannia expeditionis</u>		x	x	
<u>Udotea argentea</u>			x	x
<u>U. geppi</u>			x	
<u>Valonia ventricosa</u>		x		
PHAEOPHYTA (brown algae)				
<u>Dictyota bartayresii</u>		x	x	x
<u>D. divaricata</u>			x	x
<u>C. friabilis</u>		x	x	
<u>Lobophora variegata</u>		x	x	x
<u>Padina jonesii</u>			x	
<u>P. tenuis</u>		x		x
<u>Turbinaria ornata</u>			x	x
RHODOPHYTA (red algae)				
<u>Actinotrichia fragilis</u>		x		
<u>Amphiroa foliacea</u>		x		
<u>A. fragilissima</u>		x		

Table 6. (continued)

SPECIES	ZONES			
	1	2	3	4
<u>Centroceras minutum</u>		x		
<u>Ceramium gracillimum</u>		x		
<u>C. sp.</u>		x		
<u>Corallina sp.</u>		x		x
<u>Desmia hornemanni</u>		x		x
<u>Galaxaura marginata</u>		x	x	x
<u>Gelidiella acerosa</u>				x
<u>Gelidium crinale</u>		x		
<u>G. divaricatum</u>		x		
<u>Halymenia durvillaei</u>		x	x	x
<u>Hypnea pannosa</u>		x		x
<u>Jania capillacea</u>		x		x
<u>J. tenella</u>		x	x	x
<u>Leveillea jungermannioides</u>		x		
<u>Lithophyllum sp.</u>		x		
<u>Lithoporella sp.</u>		x		
<u>Mastophora sp.</u>		x	x	x
<u>Mesophyllum mesomorphum</u>		x		
<u>Peyssonelia rubra</u>		x		
<u>Porolithon onkodes</u>		x		x

Table 7. Checklist of corals observed at Double Reef.

SPECIES	ZONES	
	2-3	4
ANTHOZOA		
THAMNASTERIIDAE		
<u>Psammocora</u> (S.) sp.		x
POCILLOPORIDAE		
<u>Stylophora</u> mordax	x	x
<u>Pocillopora</u> damicornis	x	x
<u>P. elegans</u>	x	x
<u>P. meandrina</u>		x
<u>P. sp. 1</u>	x	x
<u>P. sp. 2</u>		x
ACROPORIDAE		
<u>Acropora</u> cuneata	x	x
<u>A. nana</u>	x	x
<u>A. humilis</u>	x	
<u>A. irregularis</u>	x	
<u>A. nasuta</u>	x	x
<u>A. squarrosa</u>	x	x
<u>A. formosa</u>	x	
<u>A. sp. 1</u>	x	x
<u>A. sp. 2</u>	x	x
<u>Montipora</u> ehrenbergii	x	x
<u>M. foveolata</u>		x
<u>M. tuberculosa</u>		x
<u>M. sp.</u>	x	
PORITIDAE		
<u>Goniopora</u> columna		x
<u>Porites</u> lutea	x	x
<u>P. matthaii</u>	x	
<u>P. sp. 1</u>	x	x
<u>P. sp. 2</u>		x
<u>P. sp. 3</u>		x
FAVIIDAE		
<u>Favia</u> sp. 1	x	x
<u>F. sp. 2</u>	x	
<u>Favites</u> abdita	x	

Table 7. (continued)

SPECIES	ZONES	
	2-3	4
<u>Plesiastrea</u> sp.	x	
<u>Coniastrea</u> sp.	x	
<u>Platygyra sinensis</u>	x	
<u>P.</u> sp.	x	
<u>Leptoria</u> sp.	x	x
<u>Leptastrea</u> sp.		x
OCULINIDAE		
<u>Galaxea</u> sp.	x	x
MUSSIDAE		
<u>Lobophyllia</u> sp. 1	x	x
<u>L.</u> sp. 2		x
HELIOPORIDAE		
<u>Heliopora coerulea</u>		x
ALCYONIIDAE		
<u>Lobophytum</u> sp.	x	
<u>Sarcophyton trocheliophorum</u>	x	x
<u>Sinularia densa</u>	x	x
<u>S.</u> sp.	x	
ZOANTHIDAE		
<u>Palythoa</u> sp.	x	
HYDROZOA		
MILLEPORIDAE		
<u>Millepora dichotoma</u>	x	x
<u>M. platyphylla</u>	x	x
<u>M. tenera</u>	x	
STYLASTERIDAE		
<u>Distichopora violacea</u>	x	

Table 8. Checklist of common macroinvertebrates observed at Double Reef.

SPECIES	ZONES		
	1	2	4
PORIFERA			
<u>Cinachyra australiensis</u>		x	x
MOLLUSCA			
AMPHINEURA			
Unknown sp.		x	
GASTROPODA			
<u>Astraea rhodostoma</u>		x	
<u>Conus ebraeus</u>		x	
<u>C. flavidus</u>		x	
<u>C. lividus</u>		x	x
<u>C. miles</u>		x	x
<u>C. rattus</u>		x	x
<u>C. sponsalis</u>		x	
<u>Cypraea caputserpentis</u>		x	x
<u>C. moneta</u>		x	x
<u>Drupa morum</u>		x	x
<u>D. ricinus</u>		x	x
<u>Mancinella tuberosa</u>		x	
<u>Morula granulata</u>		x	
<u>M. uva</u>		x	x
<u>Patella sp. 1</u>		x	
<u>P. sp. 2</u>		x	
<u>Trochus niloticus</u>		x	x
<u>Tectus pyramis</u>		x	x
<u>Vasum ceramicum</u>		x	
<u>V. turbinellus</u>		x	
BIVALVIA			
<u>Tridacna maxima</u>		x	x
CEPHALOPODA			
Unknown octopus sp.		x	
ECHINODERMATA			
ASTEROIDEA			
<u>Acanthaster planci</u>		x	x

Table 8. (continued)

SPECIES	ZONES		
	1	2	4
<u>Culcita novaguineae</u>		x	
<u>Linckia laevigata</u>		x	x
ECHINOIDEA			
<u>Echinometra mathaei</u>		x	x
<u>Echinostrephus aciculatus</u>		x	
<u>Echinothrix</u> sp.		x	x
<u>Heterocentrotus mamillatus</u>		x	
HOLOTHUROIDEA			
<u>Actinopyga echinites</u>		x	x
<u>Bohadschia argus</u>		x	
<u>Holothuria atra</u>	x	x	
<u>H. nobilis</u>		x	x
<u>Stichopus chloronotus</u>		x	
OPHIUROIDEA			
<u>Ophiocoma erinaceus</u>		x	
<u>O. sp.</u>		x	
ARTHROPODA			
CRUSTACEA			
<u>Grapsus grapsus</u>		x	
<u>Hapalocarcinus marsupialis</u>		x	
<u>Panulirus versicolor</u>		x	
<u>Trizopagurus strigatus</u>		x	

Table 9. Checklist of fishes observed at Double Reef.

SPECIES	ZONES	
	2-3	4
ACANTHURIDAE		
<u>Acanthurus glaucopareius</u>	x	x
<u>A. lineatus</u>	x	x
<u>A. nigrofuscus</u>	x	x
<u>A. sp.</u>	x	
<u>Ctenochaetus striatus</u>	x	x
<u>Naso hexacanthus</u>		x
<u>N. lituratus</u>	x	x
<u>N. unicornus</u>	x	x
<u>Zebrasoma flavescens</u>	x	
<u>Z. veliferum</u>	x	x
AULOSTOMIDAE		
<u>Aulostomus chinensis</u>	x	
BALISTIDAE		
<u>Balistes chrysopterus (=Sufflamen chrysoptera)</u>	x	x
<u>B. undulatus (=Balistapus undulatus)</u>	x	x
<u>Melichthys niger</u>		x
<u>Pseudobalistes flavomarginatus</u>		x
<u>Rhinecanthus aculeatus</u>		x
BLENNIDAE		
<u>Cirripectes sebae</u>		x
<u>C. variolosus</u>	x	
<u>Meiacanthus atrodorsalis</u>		x
CANTHIGASTERIDAE		
<u>Canthigaster margaritatus</u>	x	
<u>C. solandri</u>	x	
CHAETODONTIDAE		
<u>Centropyge bispinosus</u>	x	
<u>Chaetodon auriga</u>		x
<u>C. bennetti</u>	x	
<u>C. citrinellus</u>	x	x
<u>C. ephippium</u>	x	x
<u>C. lunula</u>	x	x
<u>C. ornatissimus</u>		x

Table 9. (continued)

SPECIES	ZONES	
	2-3	4
<u>C. punctato-fasciatus</u>		x
<u>C. reticulatus</u>	x	x
<u>C. trifasciatus</u>	x	x
<u>C. ulientensis</u>	x	x
<u>Forcipiger flavissimus</u>	x	x
CIRRHITIDAE		
<u>Cirrhitus pinnulatus</u>	x	x
<u>Paracirrhites forsteri</u>		x
GOBIIDAE		
<u>Ptereleotris tricolor</u>	x	
HEMIRAMPHIDAE		
<u>Hyporhamphus</u> sp.	x	
HOLOCENTRIDAE		
<u>Adioryx spinifer</u>	x	x
<u>Myripristis aeneus</u>		x
<u>M.</u> sp.	x	
KYPHOSIDAE		
<u>Kyphosus</u> sp.		x
LABRIDAE		
<u>Anampses caeruleopunctatus</u>	x	x
<u>A. twisti</u>	x	
<u>Cheilinus rhodochrous</u>		x
<u>C. trilobatus</u>	x	x
<u>Coris aygula</u>	x	
<u>C. gaimard</u>	x	
<u>Epibulus insidiator</u>	x	x
<u>Gomphosus varius</u>	x	x
<u>Halichoeres hortulanus</u> (=H. <u>centiquidrus</u>)	x	x
<u>H. margaritaceus</u>	x	x
<u>H. marginatus</u>	x	x
<u>Hemigymnus fasciatus</u>	x	
<u>H. melapterus</u>	x	x

Table 9. (continued)

SPECIES	ZONES	
	2-3	4
<u>Hemipteronotus taeniourus</u>	x	x
<u>Labroides bicolor</u>		x
<u>L. dimidiatus</u>	x	x
<u>Macropharyngodon meleagris</u>	x	x
<u>Stethojulis bandanensis</u>	x	x
<u>Thalassoma hardwickei</u>	x	x
<u>T. lutescens</u>	x	
<u>T. quinquevittata</u>	x	x
LETHRINIDAE		
<u>Monotaxis grandoculis</u>	x	
LUTJANIDAE		
<u>Aphareus furcatus</u>		x
<u>Lutjanus fulvus</u>	x	
<u>L. gibbus</u>	x	x
<u>L. sp. 1</u>	x	
<u>L. sp. 2</u>		x
MONACANTHIDAE		
<u>Cantherhines pardalis</u>	x	x
<u>Oxymonacanthus longirostris</u>	x	x
MULLIDAE		
<u>Parupeneus cyclostomus</u>	x	x
<u>P. trifasciatus</u>	x	x
<u>P. sp.</u>		x
OSTRACIONTIDAE		
<u>Ostracion meleagris</u>	x	x
PEMPHERIDAE		
<u>Pempheris oualensis</u>	x	
POMACENTRIDAE		
<u>Abudefduf coelestinus</u>		x
<u>A. saxatilis</u>	x	x

Table 9. (continued)

SPECIES	ZONES	
	2-3	4
<u>A. vaigiensis</u>	x	
<u>Amphiprion melanopus</u>	x	x
<u>Chromis acares</u>	x	
<u>C. atripectoralis</u>	x	x
<u>C. caerulea</u>		x
<u>Dascyllus aruanus</u>	x	
<u>D. reticulatus</u>	x	x
<u>D. trimaculatus</u>		x
<u>Glyphidodontops leucopomus</u>	x	x
<u>Pomacentrus pavo</u>	x	
<u>P. vaiuli</u>	x	
<u>Stegastes fasciolatus</u>	x	x
<u>S. sp.</u>	x	
<u>Plectroglyphidodon lacrymatus</u>	x	x
<u>P. dickii</u>		x
<u>P. sp. 1</u>		x
<u>P. sp. 2</u>		x
SCARIDAE		
<u>Scarus ghobban</u>		x
<u>S. oviceps</u>	x	
<u>S. sordidus</u>	x	
<u>S. venosus</u>	x	x
<u>S. sp. 1</u>	x	
<u>S. sp. 2</u>	x	
<u>S. sp. 3</u>		x
SERRANIDAE		
<u>Epinephelus merra</u>	x	
SIGANIDAE		
<u>Siganus argenteus</u>		x
<u>S. spinus</u>	x	
TETRAODONTIDAE		
<u>Arothron nigropunctatus</u>	x	
<u>Canthigaster solandri</u>		x
<u>C. sp.</u>		x
ZANCLIDAE		
<u>Zanclus cornutus</u>	x	x

AREA III:
HAPUTO BEACH FRINGING REEF

Haputo Beach and fringing reef (also know as B.A.B. and F.A.A. Beaches) is a small embayment on the northwest coast of Guam (Fig. 6). The surrounding land is part of the U. S. Naval Communications Station. A small access road leads to the rim at which point a foot trail and steps lead down to the beach on the north side. Calm seas and good anchorage make water access possible throughout most of the year. The white sand beach and steep surrounding cliff walls combined with a beautiful and highly diversified reef community make Haputo an excellent representative pristine marine community.

No previous survey has been done for the Haputo area with respect to the marine biotic community. A partial physiographic description of the area is given by Randall and Holloman (1974). The following summary is taken in part from their report.

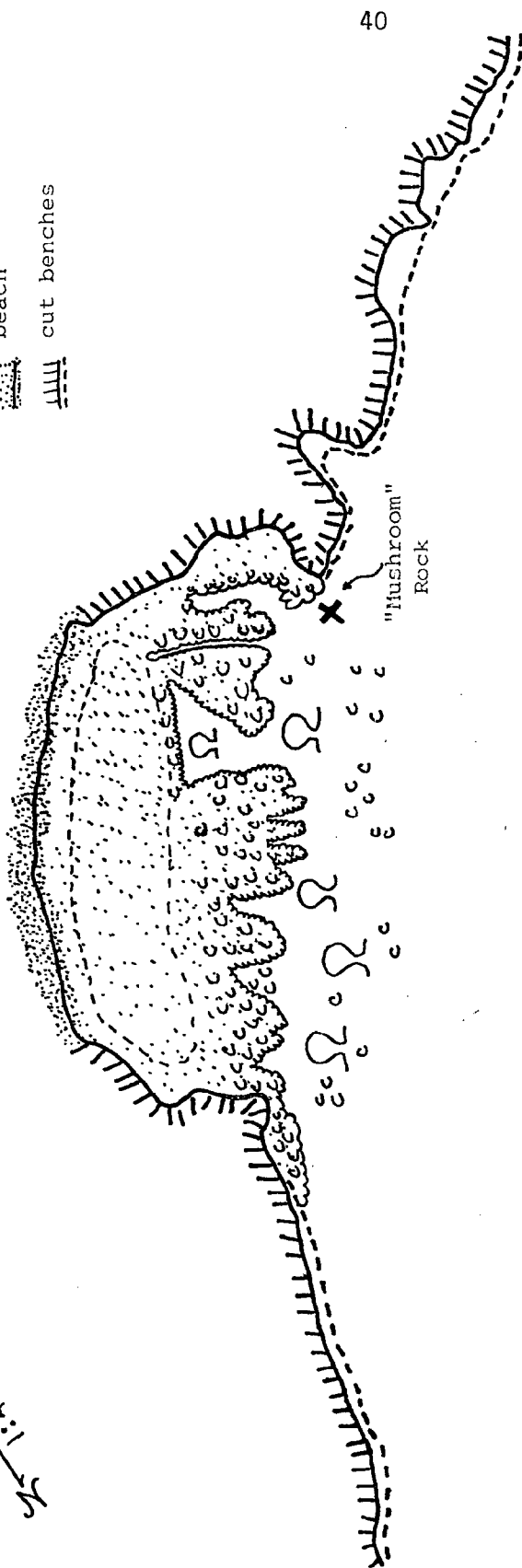
Haputo Beach measures approximately 300 meters long by 80 meters wide. The embayment is bordered by cut benches and steep rocky slopes on both the north and south sides. The south side is characterized by a series of large blocks which have broken off the cliff wall and have since eroded forming nips. One block in particular is used as a popular reference point by boaters due to its large "mushroom" shape. The beach sand is composed of coral and algal-shell debris. Randall and Holloman (1974) divide the seaward zonations into the inner and outer reef flat, reef margin and face, margin channels (here a spur and groove system), terrace and finally the submarine slope. Additional physiographic and geologic data are outlined in their report.

The Guam Environmental Protection Agency water rating for the Haputo area is "AA", conservation. No point source discharges are known in the area (Shidel, 1977).

Two visits were made to Haputo's reef. For purposes of this report three broad biotic zones were recognized. A discussion of each and its biotic components follows.

The inner reef flat zone consisted of a smooth reef-rock pavement with a 4-5 cm sand covering. Lack of a hard substrate and intermittent exposure at low tide has prevented much community development. The blue-green algae Schizothrix calcicola and Hormothamnion enteromorphoides were found in small patches throughout this zone. The calcareous green alga, Halimeda macroloba, was occasionally observed, mostly in the central reef area where sand was beginning to be replaced by coral and rock rubble.

- KEY:
- low relief corals
 - high relief corals
 - reef platform
 - rocky coastline
 - beach
 - cut benches



wide submarine terrace

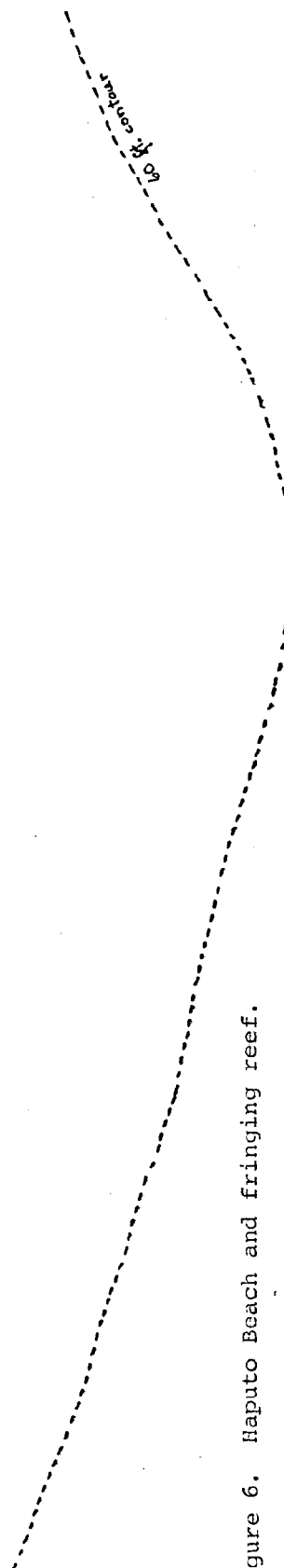


Figure 6. Haputo Beach and fringing reef.

The only corals observed in this zone were an occasional small Porites, Pocillopora or Stylophora mordax colony attached to a rock.

The macroinvertebrate Holothuria atra was also observed throughout this zone.

A few small unidentified mullet were also seen in the inner reef zone.

The second zone has been lumped to include the outer reef-flat margin and its associated channels. The nature of the biotic community and the integrated nature of these zones facilitates this. The outer reef-flat and margin areas were characterized by a porous substrate riddled with small channels, indentations and holes. The spur and groove system is well developed with some of the grooves measuring 3-4 meters deep. In several places grooves were overgrown at the top by calcareous algae and corals, forming semi-enclosed overhangs which formed a triangle in cross-section. Holes in the "mesh-like" structure admit light creating spectacular and well protected habitats for a wide variety of organisms, especially reef fishes.

Coral coverage was outstanding and diversity remarkably high for northwestern Guam. In general, colony size was less impressive than in other pristine areas examined. No single genus seemed to visually dominate though a dense cover of attractively branched Pocillopora and Acropora species were evident. Brilliant blue, purple and yellow colonies were particularly striking.

The honeycombed reef structure has resulted in a highly diversified and exceedingly rich ichthyofauna. Although only twenty-one of the ninety-five families of fish known to occur on Guam are listed, many more undoubtedly exist there but were not observed on the day of our visit. Chaetodontids and pomacentrids were visually dominant, the former being of particular interest to photographers.

Algal cover was rich and diverse with turf algae dominating the outer reef-flat and margin. Gelidium, Ceramium and Polysiphonia species dominated the turf group. The fleshy algae were widely distributed and fairly uniform in abundance. Visually dominant species included three Halimeda species, Chlorodesmis, Dictyota, Turbinaria, Amphiroa, Galaxaura, Desmia and Halymenia species. Of special importance were the crustose and coralline red algae. Outstanding examples of Mesophyllum mesomorphum, Lithophyllum, Lithoporella and Corallina species were abundant. These genera prefer shaded habitats and virtually lined the overhang and grotto areas. The protection afforded them against strong water surge has allowed extensive morphological development.

The macroinvertebrate population was rich but not particularly diverse. No particular genus was visually dominant over another.

The last zone consisted of the submarine terrace which began at a depth of approximately 6 meters, gradually sloping to a plateau depth of 15-20 meters. The effects of Acanthaster planci were less apparent than in other leeward areas. The sixty foot contour line extends approximately 1000 meters off shore at which point the submarine slope begins. The slope zone was not investigated. The terrace areas were fairly unremarkable. A few low ridges and mounds interrupted an otherwise flat topography. Occasionally large Porites colonies were seen along with small colonies of many other genera. Randall and Holloman (1974) refer to this type of coral community as non-accretional. Typical deeper water algae were also seen, notably Padina, Schizothrix and Galaxaura species.

Larger fishes patrol these areas but the general lack of protective habitats make their presence transient. A large manta-ray was observed by one team member. Tables 10-13 list the common organisms associated with the reef and adjacent areas.

CONCLUSIONS AND RECOMMENDATIONS

The Haputo fringing reef represents a rich and diverse pristine marine community. While there are no known threatened or endangered species specifically identified for this area, it is important to realize that the fragile nature of any pristine community is such that anything short of preservation and controlled recreational use could result in a large number of species being locally endangered all at once.

The following recommendations are suggested for the Haputo area:

- 1) that this area be established as a natural sanctuary in which no coral harvesting, fishing or other such activity be allowed.
- 2) that swimming, snorkeling and SCUBA diving activities should be retained. The rich corals and symbiont ichthyofauna are popular with photographers.
- 3) that mooring buoys be installed for boaters to avoid unnecessary coral breakage due to setting anchors.
- 4) that a "Thermos Law" be enforced to halt beverage can litter.
- 5) that the relatively small size and well defined boundaries of this area make it an ideal monitoring site for tropical reef habitats. Identification of indicator species is highly desirable.
- 6) that the calcareous red algal community is one of the finest around the island and should be protected for aesthetic as well as scientific purposes.

Table 10. Checklist of benthic algae observed at Haputo Beach fringing reef.

SPECIES	ZONES		
	1	2	3
CYANOPHYTA (blue-green algae)			
<u>Hormothamnion enteromorphoides</u>	x	x	
<u>Microcoleus lyngbyaceus</u>		x	x
<u>Schizothrix calcicola</u>	x	x	
<u>S. mexicana</u>	x	x	x
CHLOROPHYTA (green algae)			
<u>Bryopsis pennata</u>		x	x
<u>Boodlea composita</u>		x	
<u>Caulerpa filicoides</u>		x	
<u>C. racemosa</u>		x	
<u>Chlorodesmis fastigiata</u>		x	x
<u>Codium edule</u>		x	
<u>Enteromorpha clathrata</u>		x	
<u>Halimeda gigas</u>		x	x
<u>H. macroloba</u>	x	x	x
<u>H. opuntia</u>		x	x
<u>H. velasquezii</u>		x	x
<u>Neomeris annulata</u>		x	x
<u>Tydemannia expeditionis</u>		x	x
<u>Udotea argentea</u>		x	x
PHAEOPHYTA (brown algae)			
<u>Dictyota bartayresii</u>		x	
<u>D. friabilis</u>		x	
<u>Lobophora variegata</u>	x	x	x
<u>Padina minor</u>		x	x
<u>Padina tenuis</u>		x	
<u>Turbinaria ornata</u>		x	
RHODOPHYTA (red algae)			
<u>Actinotrichia fragilis</u>		x	
<u>Amphiroa fragilissima</u>		x	
<u>A. foliacea</u>		x	
<u>A. sp.</u>		x	
<u>Asparagopsis taxiformis</u>		x	
<u>Ceramium gracillimum</u>		x	
<u>Corallina sp.</u>		x	

Table 10. (continued)

SPECIES	ZONES		
	1	2	3
<u>Desmia hornemanni</u>		x	x
<u>Galaxaura marginata</u>		x	x
<u>Gelidium</u> sp.		x	
<u>Halymenia durvillaei</u>		x	
<u>Hypnea pannosa</u>		x	
<u>Jania capillacea</u>		x	
<u>Lithophyllum</u> sp.		xx	
<u>Lithoporella</u> sp.		xx	
<u>Mastophora</u> sp.		x	
<u>Mesophyllum mesomorphum</u>		xx	
<u>Mesophyllum</u> sp.		x	
<u>Polysiphonia</u> sp.		x	
<u>Porolithon onkodes</u>		xx	
<u>Pterocladia parva</u>		x	
<u>Tolypiocladia glomerulata</u>		x	

SPERMATOPHYTA (seagrasses)

none seen

Table 11. Checklist of corals observed at Haputo Beach fringing reef.

SPECIES	ZONES		
	1	2	3
ANTHOZOA			
POCILLOPORIDAE			
<u>Stylophora mordax</u>	x	x	
<u>Pocillopora elegans</u>	x	x	
<u>P. eydouxi</u>	x	x	
<u>P. meandrina</u>	x	x	
<u>P. setchelli</u>	x	x	
<u>P. verrucosa</u>	x	x	
ACROPORIDAE			
<u>Acropora humilis</u>		x	
<u>A. palifera</u>		x	
<u>A. sp. 1</u>		x	
<u>A. sp. 2</u>		x	
<u>Astreopora sp.</u>		x	
<u>Montipora ehrenbergii</u>		x	
<u>M. foveolate</u>		x	
<u>M. sp.</u>		x	
AGARICIIDAE			
<u>Pavona sp. 1</u>		x	
<u>P. sp. 2</u>		x	
<u>P. sp. 3</u>		x	
<u>P. sp. 4</u>		x	
<u>P. sp. 5</u>		x	
PORITIDAE			
<u>Goniopora sp.</u>		x	
<u>Porites sp. 1</u>	x	x	x
<u>Porites sp. 2</u>		x	x
FAVIIDAE			
<u>Favia pallida</u>		x	
<u>Plesiastrea sp.</u>		x	
<u>Goniastrea retiformis</u>		x	
<u>Platygyra rustica</u>		x	
<u>Leptoria phrygia</u>		x	
<u>Hydnophora microconos</u>		x	

Table 11. (continued)

SPECIES	ZONES		
	1	2	3
<u>Leptastrea purpurea</u>		x	
<u>L. sp.</u>		x	
<u>Cyphastrea sp. 1</u>		x	
<u>C. sp. 2</u>		x	
<u>Echinopora sp.</u>		x	
MUSSIDAE			
<u>Lobophyllia sp.</u>		x	
HELIOPORIDAE			
<u>Heliopora coerulea</u>		x	
ALCYONIIDAE (soft corals)			
<u>Sinularia densa</u>		x	
<u>Sarcophyton sp.</u>		x	
HYDROZOA			
MILLEPORIDAE			
<u>Millepora exaesa</u>		x	x
<u>M. platyphylla</u>		x	x

Table 12. Checklist of common macroinvertebrates observed at Haputo Beach fringing reef.

SPECIES	ZONES		
	1	2	3
PORIFERA			
<u>Cinachyra australiensis</u>		x	x
MOLLUSCA			
GASTROPODA			
<u>Cerithium nodulosum</u>		x	
<u>Conus ebraeus</u>		x	
<u>C. miles</u>		x	
<u>C. sponsalis</u>		x	
<u>Cypraea caputserpentis</u>		x	
<u>C. isabella</u>		x	
<u>C. moneta</u>		x	
<u>Drupa morum</u>		x	
<u>D. ricinus</u>		x	
<u>Latirus sp.</u>		x	
<u>Morula granulata</u>		x	
<u>M. uva</u>		x	
<u>Nerita plicata</u>		x	
<u>Patella sp.</u>		x	
<u>Terebra sp.</u>		x	
<u>Trochus niloticus</u>		x	
<u>Turbo sp.</u>		x	
<u>Vasum turbinellus</u>		x	
BIVALVIA			
<u>Tridacna maxima</u>		x	x
ECHINODERMATA			
ASTEROIDEA			
<u>Culcita novaeguineae</u>		x	
<u>Linckia laevigata</u>		x	
<u>L. multiflora</u>		x	x
ECHINOIDEA			
<u>Echinometra mathaei</u>		x	
<u>Echinothrix calamaris</u>		x	
<u>Echinostrephus aciculatus</u>		x	

Table 12. (continued)

SPECIES	ZONES		
	1	2	3
HOLOTHUROIDEA			
<u>Actinopyga echinites</u>		x	
<u>A. mauritiana</u>		x	
<u>Holothuria atra</u>	x	x	
ARTHROPODA			
CRUSTACEA			
<u>Grapsus grapsus</u>		x	

Table 13. Checklist of fishes observed at Haputo Beach fringing reef. All observations made in Zone 2.

SPECIES	ZONES		
	1	2	3
<u>ACANTHURIDAE</u>			
<u>Acanthurus glaucopareius</u>		x	
<u>A. lineatus</u>		x	
<u>A. nigricans</u> (=A. <u>gahhm</u>)		x	
<u>A. nigrofuscus</u>		x	
<u>A. olivaceous</u>		x	
<u>A. pyroferus</u>		x	
<u>A. xanthopterus</u>		x	
<u>Ctenochaetus striatus</u>		x	
<u>Naso brevirostris</u>		x	
<u>N. lituratus</u>		x	
<u>APOGONIDAE</u>			
<u>Apogon novae-guineae</u>		x	
<u>A. novemfasciatus</u>		x	
<u>BALISTIDAE</u>			
<u>Balistes bursa</u> (=Sufflamen <u>bursa</u>)		x	
<u>B. chrysopterus</u> (=Sufflamen <u>chrysoptera</u>)		x	
<u>Melichthys vidua</u>		x	
<u>Rhinecanthus rectangulus</u>		x	
<u>BLENNIIDAE</u>			
<u>Cirripectes variolosus</u>		x	
<u>C. guagga</u>		x	
<u>Meiacanthus atrodorsalis</u>		x	
<u>Plagiotremus tapeinosoma</u>		x	
<u>CANTHIGASTERIDAE</u>			
<u>Canthigaster bennetti</u>		x	
<u>C. solandri</u>		x	
<u>CHAETODONTIDAE</u>			
<u>Centropyge flavissimus</u>		x	
<u>Chaetodon auriga</u>		x	
<u>C. citrinellus</u>		x	
<u>C. ephippium</u>		x	

Table 13. (continued)

SPECIES	ZONES		
	1	2	3
<u>C. lunula</u>		x	
<u>C. mertensii</u>		x	
<u>C. ornatissimus</u>		x	
<u>C. punctato-fasciatus</u>		x	
<u>C. quadrimaculatus</u>		x	
<u>C. reticulatus</u>		x	
<u>C. trifasciatus</u>		x	
<u>C. ulietensis</u>		x	
<u>Forcipiger longirostris</u>		x	
<u>Heniochus monoceros</u>		x	
<u>Holacanthus trimaculatus</u>		x	
CIRRHITIDAE			
<u>Cirrhitus pinnulatus</u>		x	
<u>Neocirrhites armatus</u>		x	
<u>Paracirrhites forsteri</u>		x	
GOBIIDAE			
<u>Nemateleotris magnificus</u>		x	
<u>Ptereleotris microlepis</u>		x	
<u>P. tricolor</u>		x	
<u>Valenciennesa strigata</u>		x	
HOLOCENTRIDAE			
<u>Adioryx spinifer</u>		x	
<u>Flammeo sammara</u>		x	
<u>Myripristis kuntei</u>		x	
KYPHOSIDAE			
<u>Kyphosus vaigiensis</u>		x	
LABRIDAE			
<u>Bodianus axillaris</u>		x	
<u>Cheilinus rhodochrous</u>		x	
<u>C. trilobatus</u>		x	
<u>Coris aygula</u>		x	
<u>C. gaimard</u>		x	
<u>Epibulus insidiator</u>		x	
<u>Gomphosus varius</u>		x	
<u>Halichoeres hortulanus</u> (=H. <u>centigusrus</u>)		x	
<u>H. margaritaceus</u>		x	

Table 13. (continued)

SPECIES	ZONES		
	1	2	3
<u>H. trimaculatus</u>		x	
<u>H. sp.</u>		x	
<u>Labroides bicolor</u>		x	
<u>L. dimidiatus</u>		x	
<u>Macropharyngodon pardalis</u>		x	
<u>Thalassoma lutescens</u>		x	
<u>T. quinquevittata</u>		x	
LUTJANIDAE			
<u>Aprion virescens</u>		x	
<u>Gnathodentex aureolineatus</u>		x	
<u>Lethrinus sp.</u>		x	
<u>Lutjanus fulvus</u>		x	
<u>Monotaxis grandoculis</u>		x	
<u>Plectorhincus chaetodonoides</u>		x	
MOBULIDAE			
<u>Manta sp.</u>		x	
MONACANTHIDAE			
<u>Oxymonacanthus longirostris</u>		x	
MUGILOIDIDAE			
<u>Parapercis sp.</u>		x	
MULLIDAE			
<u>Parupeneus barberinus</u>		x	
<u>P. bifasciatus</u>		x	
<u>P. cyclostomus</u>		x	
<u>P. multifasciatus</u>		x	
<u>P. sp.</u>	x	x	
OSTRACIONTIDAE			
<u>Ostracion melagris</u>		x	
POMACENTRIDAE			
<u>Chromis margaritifer</u>		x	
<u>C. xanthura</u>		x	

Table 13. (continued)

SPECIES	ZONES		
	1	2	3
<u>C. sp.</u>		x	
<u>Dascyllus reticulatus</u>		x	
<u>D. trimaculatus</u>		x	
<u>Dischistodus perspicillatus</u>		x	
<u>Glyphidodontops leucopomus</u>		x	
<u>G. tracyi</u>		x	
<u>Neopomacentrus hemurus</u>		x	
<u>Plectroglyphidodon imparipennis</u>		x	
<u>P. johnstonianus</u>		x	
<u>P. lacrymatus</u>		x	
<u>Pomacentrus vaiuli</u>		x	
SCARIDAE			
<u>Scarus ghobban</u>		x	
<u>S. lepidus</u>		x	
<u>S. sordidus</u>		x	
<u>S. venosus</u>		x	
<u>S. sp. 1</u>		x	
<u>S. sp. 2</u>		x	
<u>S. sp. 3</u>		x	
SERRANIDAE			
<u>Cephalopholis urodelus</u>		x	
<u>Grammistes sexlineatus</u>		x	
ZANCLIDAE			
<u>Zanclus cornutus</u>		x	

AREA IV:
LUMINAO BARRIER REEF

Luminao Reef is one of two barrier reefs on Guam. Extending west from Cabras Island and continuous with the submerged Callalan Bank, Luminao Barrier Reef serves as the foundation for Glass Breakwater. The entire area lies within the boundaries of Apra Harbor Naval Reservation.

A highly diversified reef community (Fig. 7) combined with calm waters and easy access from the breakwater, has made the Luminao area a popular place for snorkelers and photographers. The apparent stability and active reef growth of this area permit its consideration as a pristine marine community under the criteria of reestablishment.

No previous survey has been conducted for this area with respect to the marine biotic community. Randall and Holloman (1974) provide information on physiography, geology and hydrology. The following is summarized from their report.

Luminao Barrier Reef forms a wide, shallow platform cut by an intermittent spur and groove system. Considerable reef-building is taking place in several locales. A narrow submarine terrace, 3-5 meters in depth, abruptly drops at the (18 meter) 60 feet contour. The lagoon side of Luminao Reef has for the most part been altered by dredging, filling and construction. This area was not considered in this report.

The Guam Environmental Protection Agency water quality classification for this area is "A", recreational. No point source discharges are known (Shidel, 1977).

The western end of the seaward side of the barrier reef was chosen for this study. Only the reef flat platform was examined. A narrow sandy inner reef strip approximately 3-4 meters wide runs parallel to the breakwater. The wide middle reef platform consists of a uniform moat varying from 1-3 meters deep. Many coral colonies are exposed during low tides. A narrow outer reef flat is exposed at low tide and was generally depauperate with occasional patches of the brown alga, Sargassum polycystum. For purposes of this report, no distinctly different biotic zones were recognized. See Tables 14-17 for species lists.

The coral community was highly diverse and luxuriant. Large mounds of Acropora, Porites and Millepora were abundant. Some colonies were 1.5 meters or more in width. The upper portions of many Porites heads were exposed at low tide and thus dead. Many turf and fleshy algae crown the tops of these colonies. Porites andrewsi and Porites cocosensis were most common in the inner reef flat, while Millepora dichotoma and Millepora platyphylla (fire corals) were more abundant

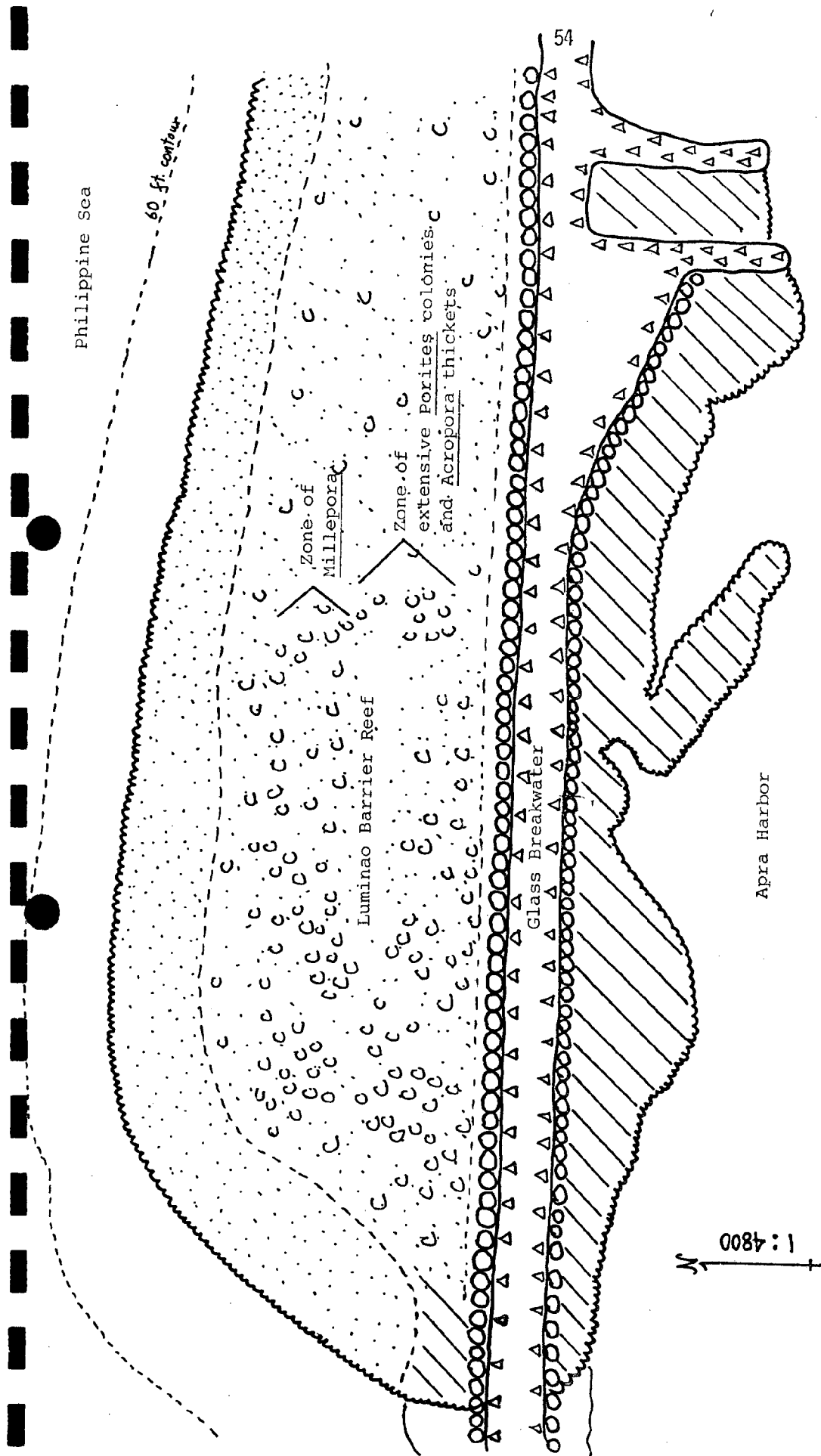


Figure 7. Extreme western section of Luminao Barrier Reef. Only the north side was investigated.

towards the middle and outer moat areas. Of particular interest were the presence of corals typically associated with the margin and terrace areas.** These large Pocillopora colonies were common in the moat.

The soft corals, Sinularia, Lobophytum and Sarcophyton species were common and well developed. Some colonies were more than a meter in diameter.

Luminao Barrier Reef exhibits a moderately diverse algal cover and diversity. The green alga Boergesenia forbesii was common along the narrow sandy inner strip, while Sargassum polycystum dominated the outer reef flat and margin. Halimeda and Caulerpa species were abundant in the side moat along with many smaller forms. The dead and exposed portions of Porites colonies were covered with Amphiroa, Caulerpa, Halimeda and Schizothrix species. Other less conspicuous genera were also abundant.

A colorful and diverse array of reef fishes were observed. Acanthurids, chaetodontids, pomacentrids and labrids were common.

The sea cucumbers Actinopyga echinites and Holothuria atra were common in the shallow sandy areas near the breakwater, while Stichopus chloronotus and Bohadschia argus were common in the middle reef sections. The blue starfish Linckia laevigata was also common.

CONCLUSIONS AND RECOMMENDATIONS

Luminao Barrier Reef is one of the few readily accessible pristine areas covered in this survey. The barrier reefs of the Cocos Lagoon complex are the only alternative sites. Calm, shallow water combined with a diverse and beautiful reef community make this area a good candidate for preservation.

The following recommendations are suggested:

- 1) that this area be established as a natural sanctuary in which no coral harvesting, net fishing or other such activity be permitted.
- 2) that a series of underwater trails be developed with appropriate supportive literature and signs.

**R. H. Randall, personal communication.

Table 14. Checklist of benthic marine algae observed on the reef flat at Luminao Barrier Reef. * = present on tops of exposed Porites colonies.

SPECIES

CYANOPHYTA (blue-green algae)

Anacystis sp.
Calothrix sp.
 *Microcoleus lyngbyaceus
 *Schizothrix calcicola
Schizothrix mexicana

CHLOROPHYTA (green algae)

Boergesenia forbesii
Caulerpa cupressoides
 *C. racemosa
C. serrulata
Chlorodesmis fastigiata
 *Dictyosphaeria versluysii
Enteromorpha clathrata
 *Halimeda opuntia
 *Neomeris annulata
Tydemannia expeditionis

PHAEOPHYTA (brown algae)

Dictyota bartayresii
Ectocarpus breviarticulatus
 *Lobophora variegata
Padina tenuis
Sargassum polycystum
Turbinaria ornata

RHODOPHYTA (red algae)

Actinotrichia fragilis
Amphiroa foliacea
 *A. fragilissima
Ceramium sp.
Galaxaura marginata
Gelidiella acerosa
Gelidium pusillum
Gelidium divaricatum
Hypnea pannosa
Hydrolithon sp. (nodules)
Polysiphonia sp.

Table 15. Checklist of corals observed on the reef flat at Luminao Barrier Reef.

SPECIES

ANTHOZOA

THAMNASTERIIDAE

Psammocora contigua
P. togianensis
P. sp.

POCILLOPORIDAE

Pocillopora damicornis
P. danae
P. elegans
P. eydouxi
P. ligulata
P. setchelli
P. meandrina
P. sp.

ACROPORIDAE

Acropora aspera
A. formosa
A. humilis
A. hystrix
A. irregularis
A. kenti
A. nana
A. nasuta
A. palifera
Astreopora sp.
Montipora hoffmeisteri
M. lobulata
M. monasteriata
M. patula
M. tuberculosa
M. verrucosa
M. sp. 1
M. sp. 2

AGARICIDAE

Pavona decussata
P. (Polyastra) obtusata
P. sp.

FUNGIIDAE

Fungia fungites
F. sp.

PORITIDAE

Goniopora arbuscula
G. tenvidens
Porites andrewsi
P. annae
P. cocosensis
P. (Synaraea) convexa
P. (Synaraea) iwayamaensis
P. lobata
P. lutea
P. matthaii
P. sp.

FAVIIDAE

Favia favius
F. pallida
F. stelligera
Favites abdita
Platygyra rustica
P. sinensis
Leptoria phrygia
Leptastrea bottae
L. purpurea
L. sp.
Cyphastrea sp.

MUSSIDAE

Lobophyllia costata
L. corymbosa

HELIOPORIDAE

Heliopora coerulea

Table 15. (continued)

SPECIES

ALCYONIIDAE

Lobophytum sp.Sarcophyton sp.Sinularia sp.

HYDROZOA

Millepora dichotomaM. platyphylla

Table 16. Checklist of common macroinvertebrates observed on the reef flat at Luminao Barrier Reef.

SPECIES

MOLLUSCA

GASTROPODA

Cantharus undosus
Cerithium nodulosum
C. sp.
Conus ebraeus
C. flavidus
C. miliaris
C. pulicarius
Coralliophila violacea
Cypraea erosa
C. moneta
Drupa morum
D. ricinus
Imbricaria punctata
Lambis lambis
Littorina coccinea
Mitra mitra
Morula granulata
M. uva
Nerita plicata
Patella sp.
Rhinoclavis asperi
Strombus luhuanus
S. mutabilis
Tectus pyramis
Trochus niloticus
Vasum turbinellus
Vexillum sp.

BIVALVIA

Scutarcopagia scobinata
Tridacna maxima

ECHINODERMATA

ASTEROIDEA

Culcita novaeguineae
Echinaster luzonicus
Linckia laevigata
L. multiflora

ECHINODEA

Diadema savignyi
Echinometra mathaei
Echinothrix calamaris
E. diadema
Eucidaris metularia

HOLOTHUROIDEA

Actinopyga echinites
Bohadschia argus
Holothuria atra
H. hilla
H. nobilis
Stichopus chloronotus
Synapta maculata

ARTHROPODA

CRUSTACEA

Grapsus grapsus
Xanthid sp.

Table 17. Checklist of fishes observed on the reef flat at Luminao Barrier Reef.

SPECIES

ACANTHURIDAE

Acanthurus lineatus
A. nigrofuscus
A. triostegus
Ctenochaetus striatus
Naso lituratus
N. sp.
Zebrasoma flavescens
Z. veliferum

APOGONIDAE

Apogon novemfasciatus

BALISTIDAE

Rhinecanthus aculeatus
R. rectangulus

BLENNIDAE

Meiacanthus atrodorsalis
Plagiotremus tapeinosoma
"Blenny" sp.

CANTHIGASTERIDAE

Canthigaster bennetti
C. solandri

CHAETODONTIDAE

Chaetodon auriga
C. citrinellus
C. ephippium
C. lunula
C. ornatissimus
C. reticulatus
C. trifascialis
C. trifasciatus
C. ulietensis
C. unimaculatus
Heniochus chrysostomus

CIRRHITIDAE

Paracirrhites forsteri

GOBIIDAE

Valenciennea strigata

HOLOCENTRIDAE

Adioryx spinifer
A. sp.

LABRIDAE

Anampses caeruleopunctatus
Cheilinus chlorourus
C. trilobatus
C. undulatus
Coris gaimard
Epibulus insidiator
Gomphosus varius
Halichoeres hortulanus (H. centiquadrus)
H. margaritaceus
H. marginatus
H. trimaculatus
H. sp.
Hemigymnus melapterus
Labroides dimidiatus
Macropharyngodon meleagris
Stethojulis bandanensis
S. linearis
Thalassoma hardwicki
T. lutescens
T. umbrostygma

LUTJANIDAE

Lutjanus fulvus
L. sp.

MONACANTHIDAE

Amanses carolae
Oxymonacanthus longirostris

Table 17. (continued)

SPECIES

MULLIDAE

Mulloidichthys samoensis
Parupeneus barberinus
P. bifasciatus
P. cyclostomus
P. trifasciatus

NEMIPTERIDAE

Scolopsis cancellatus

POMACENTRIDAE

Abudefduf coelestinus
A. sordidus
Amblyglyphidodon curacao
Amphiprion melanopus
Chromis caerulea
Dascyllus aruanus
D. trimaculatus
Glyphidodontops cyaneus
G. glaucus
G. leucopomus
Plectroglyphidodon dickii
P. leucozoma
Pomacentrus pavo
P. vaiuli
Stegastes albifasciatus
S. fasciolatus
S. lividus
S. nigricans

SCARIDAE

Scarus lepidus
S. sexvittatus
S. sordidus
S. sp. 1
S. sp. 2
S. sp. 3
S. sp. 4

SCORPAENIDAE

Synanceia verrucosa

SIGANIDAE

Siganus spinus

SYNGNATHIDAE

Corythoichthys intestinalis

SYNODONTIDAE

Synodus sp.

TETRAODONTIDAE

Arothron nigropunctatus

ZANCLIDAE

Zanclus cornutus

AREA V:
EAST APRA HARBOR WETLANDS - SASA BAY
AND ATANTANO RIVER MANGROVES

Like coral reefs, mangrove communities are unique to tropical and subtropical latitudes, but unlike coral reefs, mangroves are not typically striking areas of color and form. The associated mudflats, extensively intertwining prop root systems and pungent odor during low tides has made them prime candidates for destruction or modification by man. Land reclamation is relatively easy and many of the best representative communities have been destroyed.

The dynamics of this community type include both land building and erosional protection. The prop root system reduces tidal currents and traps much floating debris, resulting in extensive deposition of sediments. The resulting mudflats provide burrows for mud crabs and the prop roots, attachment sites for a variety of molluscs. In addition, mangroves exhibit high primary productivity and possibly represent the best example of the detrital food chain (Odum, 1971).

Three excellent reports have been prepared in recent years identifying and assessing the biologic components of wetlands and, more specifically, mangrove communities on Guam.

Moore et al. (1977) studied seventeen wetland areas. Their report includes descriptions, maps, keys, photographs and inventories of associated flora. This study will provide a solid working base for any wetland associated project.





A report by the University of Guam Marine Laboratory (1977) provides information on Sasa Bay in general. They divided the area into four regions, one of which included the mudflat and mangrove communities along the east side. Species lists were gleaned from this report.

Wilder (1976) mapped the estuaries and mangroves around Guam. These maps have been used as a base in this report.

Physiographic data was taken from Randall and Holloman (1974) and additional map information from Randall and Eldredge (1976). All of these reports contain additional bibliographical references.

The GEPA water quality classification for this area is "A", recreational use. No point source discharges are known for this area though it is likely that intermittent discharges do occur in relation to the many commercial and industrial activities in the harbor.

The east Sasa Bay and Atantano River mangroves were selected. Both lie in the Apra Harbor wetland area (Figs. 8 and 9). Although extensive

KEY:  mangroves
 sand and mud
 reef margin
 seagrass beds

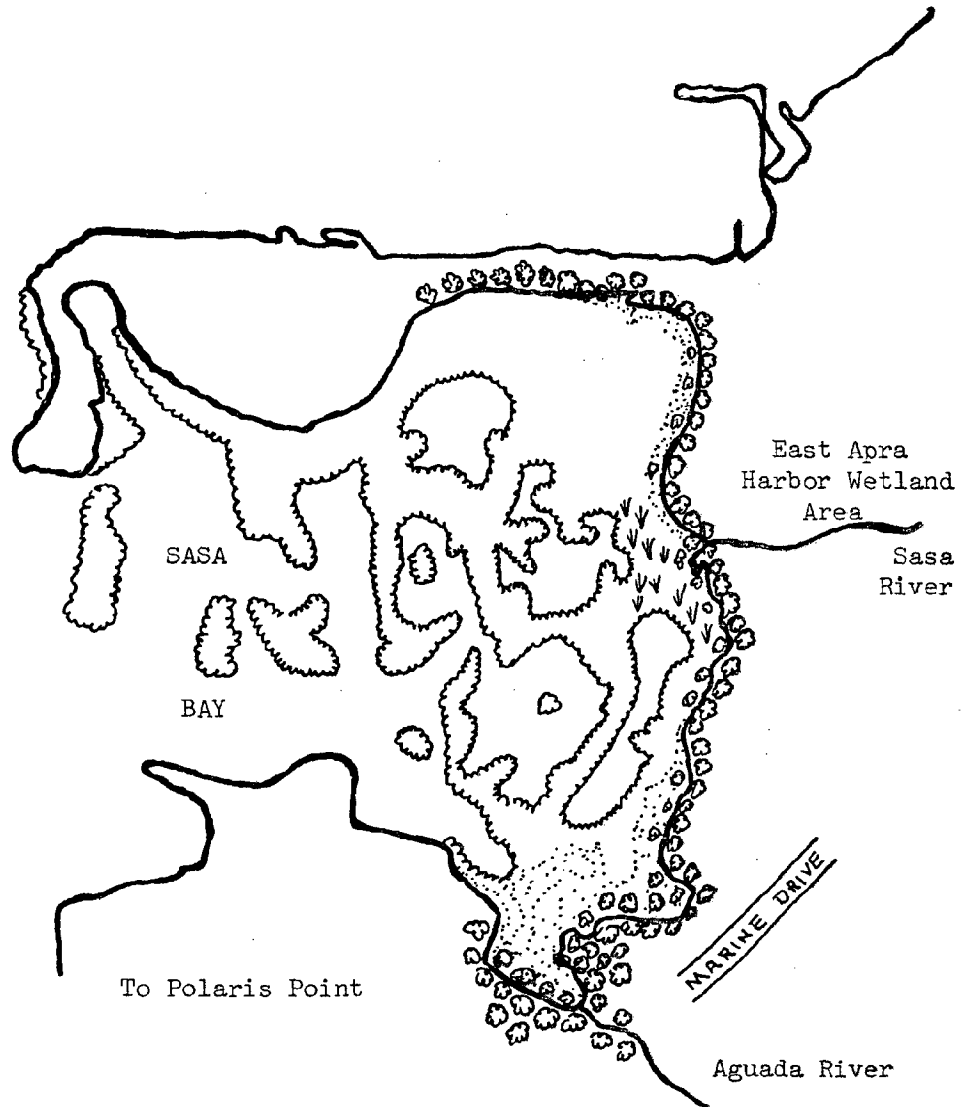
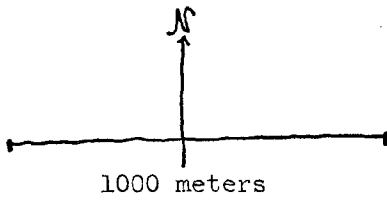


Figure 8. East Sasa Bay Mangroves

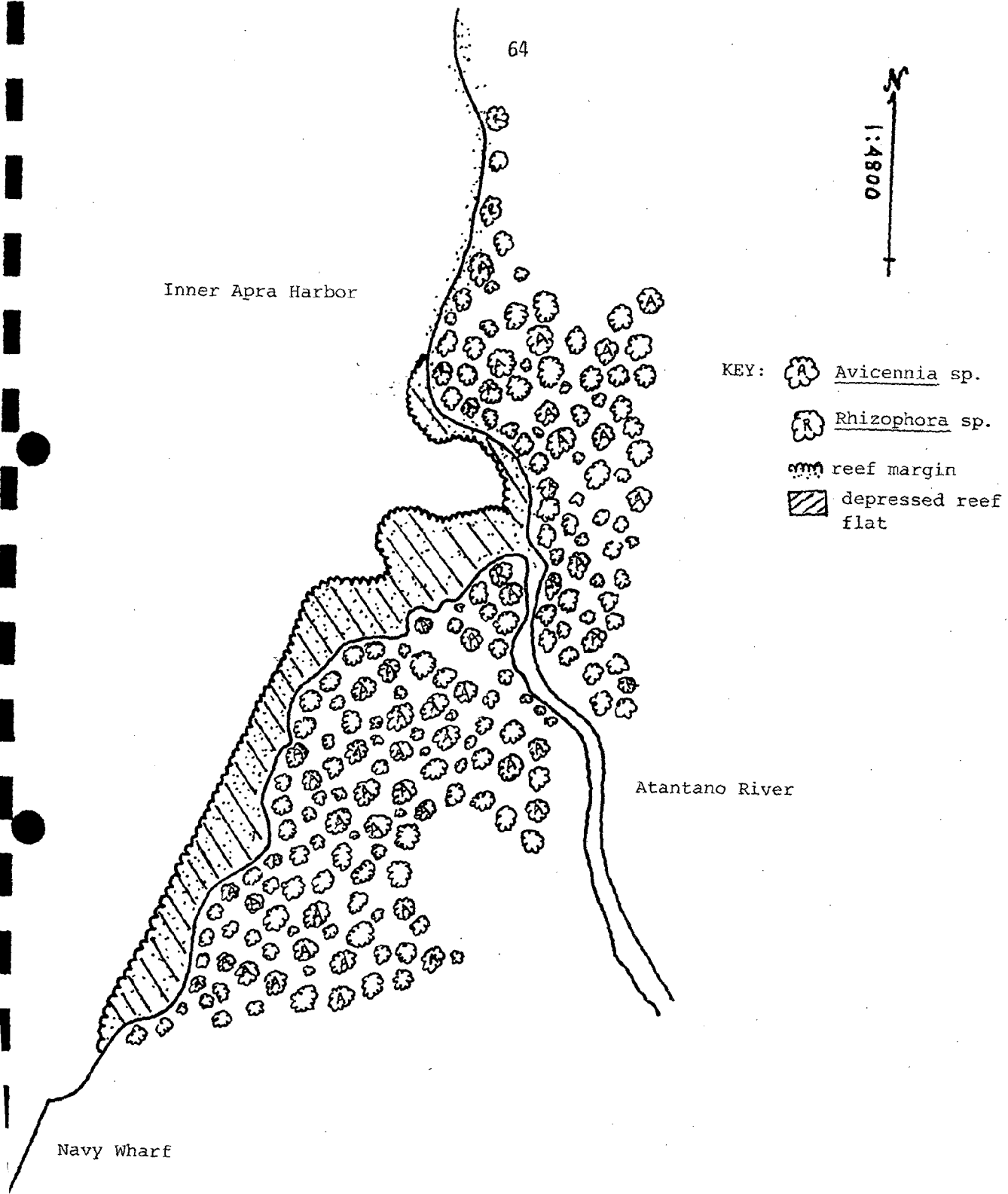


Figure 9. Atantano River mangrove community.

modification of these areas has occurred in the past with the construction of Route 1 (Marine Drive), dredging, construction and landfill (extending from the Dry Dock Peninsula, east and south, to Polaris Point), these areas still represent the most extensive and mature mangrove communities on Guam. In keeping with the definition of pristine, these areas have met the criterion of reestablishment.

Wetland zonation is typically divided into seven sections. See Figure 10 (Coastal Zone Management, 1977). Standard marine species lists of corals and fishes are replaced by benthic algae, terrestrial plants and mangrove associated macroinvertebrates (Tables 18-20). Terrestrial vertebrates such as rodents and birds were not included.

The Sasa mangroves are estimated to be 90 percent Rhizophora mucronata and R. apiculata (University of Guam Marine Laboratory, 1977). Other dominant mangrove species include Bruguiera gymnorhiza, Avicennia alba and Lumnitzera littorea. Moore *et al.* (1977) found that the mangrove sediments were ankle-deep in most places. Large patches of mature mangroves were observed with interspersed patches of less mature plants. On the seaward, peripheral edge of the mangrove, large stands of the seagrass Enhalus acoroides were abundant.

Moore *et al.* (1977) considers the mangrove swamp at the Atantano River mouth to be the best developed, most mature stand on Guam. Avicennia alba dominates. A particularly dense stand can be found on the north side of the river mouth. Rhizophora apiculata accounts for less than five percent (Wilder, 1976) along with Bruguiera gymnorhiza and Rhizophora mucronata, which were also abundant. The mangrove associated plants Dalbergia candenatensis, Barringtonia asiatica and Pluchea indica were also present. The interior of the marsh is dominated by Phragmites karka and Hibiscus tiliaceus.

Three algal genera were observed. The cyanophytes Schizothrix and Microcoleus were attached to the prop roots of some plants and the green alga Avrainvillea obscura was occasionally seen interspersed with the seagrass.

The substratum along the east bay area was composed of thick mud and silt. A typical mangrove invertebrate community is described by the University of Guam Marine Laboratory (1977). The high intertidal gastropod, Littorina scabra was by far the most dominant, typically attached to prop roots and low-hanging mangrove leaves. The oyster Saxostrea mordax was also found attached to prop roots. Other common species included fiddler crabs (Uca sp.), grapsid and portunid crabs, cerithiid gastropods (near Sasa River mouth only) and occasionally the mudskipper, Periopthalmus koelreuteri.

The presence of numerous crab burrows and freshly broken bivalve shells slightly north of the Sasa River was suggestive of the presence of the mangrove crab, Scylla serrata, though none were seen.

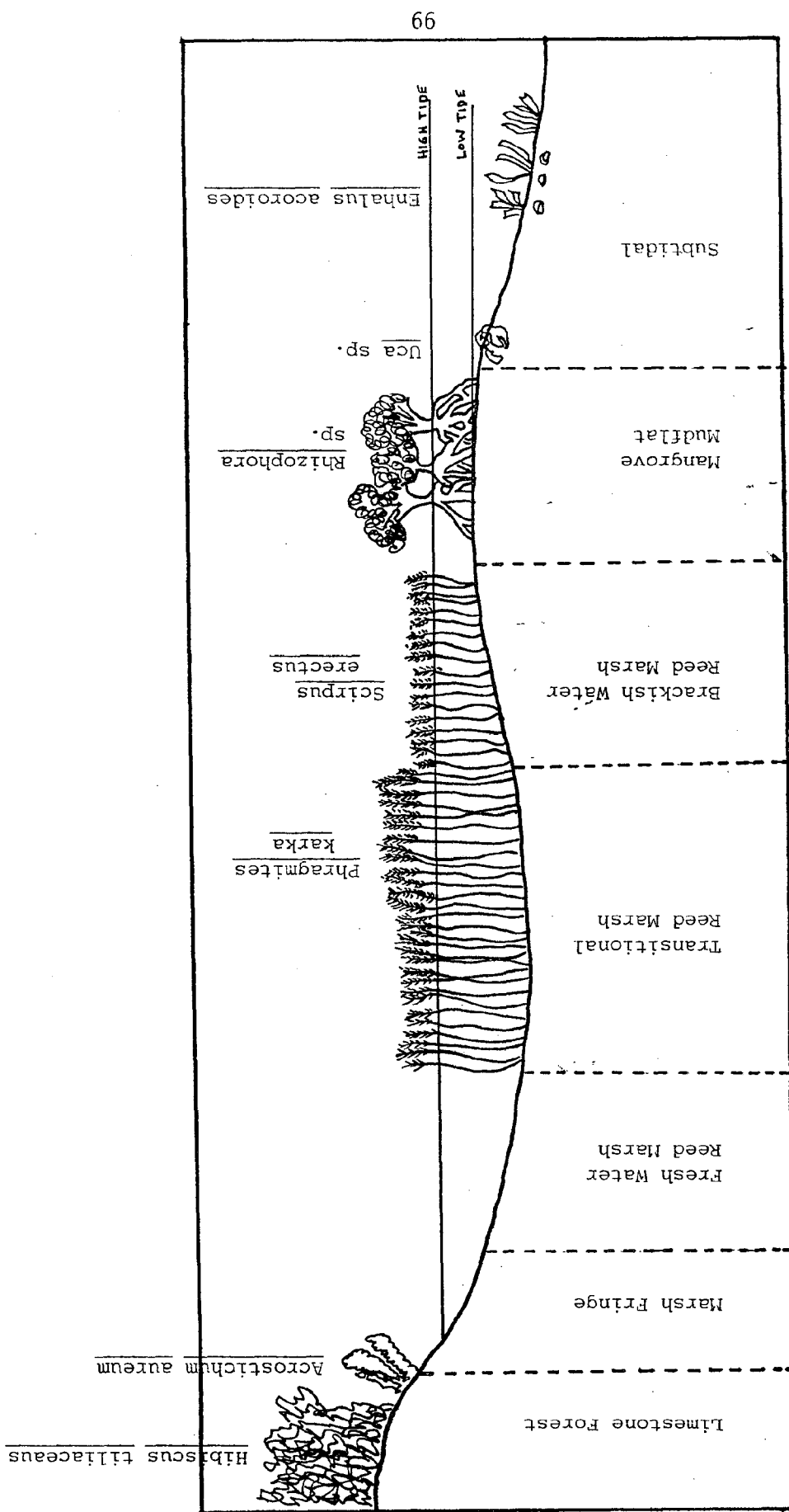


Figure 10. Generalized cross-section of mangrove river mouth showing typical zonation pattern.
(Adapted from CZM Newsletter 1977).

Moore et al. (1977) considers the mangrove plants, Lumnitzera littorea, Bruguiera gymnorhiza, Xylocarpus moluccensis, Rhizophora mucronata, R. apiculata and Barringtonia racemosa to be endangered. Although these species are locally abundant, their critical habitats are severely threatened by wetland modifications of any kind.

CONCLUSIONS AND RECOMMENDATIONS

Since mangroves are an integral component of wetlands, it follows that modification or destruction of the associated wetlands will bring about the eventual demise of the mangrove. In addition, the less extensive development of mangrove communities on Guam in comparison to other Micronesian islands, for example, tends to magnify their importance as nursery areas for many organisms. For these reasons, mangrove preservation on Guam is of the utmost importance.

It is recommended that:

- 1) preservation of these areas include the adjacent support-wetland community.
- 2) the landfill, dredging and pollutant discharges be severely regulated.
- 3) a walkway-system and nature trail should be constructed to provide both public education and enjoyment as well as access for scientific investigation.

Table 18. Checklist of wetland associated plants observed in eastern Apra Harbor. A = abundant, C = common, and R = rare. (adapted from Moore et al., 1977).

SPECIES	Sasa	Atantano
FILICINAE		
ASPIDIACEAE		
<u>Thelypteris interrupta</u>		R
PTERIDACEAE		
<u>Acrostichum aureum</u>	C	C
<u>Pteris vittata</u>	C/R	
ANGIOSPERMAE		
ARACEAE		
<u>Alocasia macrorrhiza</u>	R	
CYPERACEAE		
<u>Cyperus compressus</u>	C	
<u>C. javanicus</u>	C/R	
<u>C. odoratus</u>	C	C
<u>Fimbristylis cymosa</u>	C	C
<u>F. dichotoma</u>	C	C
<u>F. globulosa</u>	C	
<u>Scirpus littoralis v. thermalis</u>	A	
<u>Scleria lithosperma</u>	C	
<u>S. polycarpa</u>	C	
<u>Rhynchospora corymbosa</u>	C	
FLAGELLARIACEAE		
<u>Flagellaria indica</u>	C	C
GRAMINEAE		
<u>Bambusa vulgaris</u>	C	
<u>Brachiara mutica</u>	C	
<u>Centothecca lappacea</u>		C
<u>Eleusine indica</u>	C	
<u>Imperata confecta</u>	C	
<u>Oplismenus sp.</u>	C	C
<u>Panicum maximum</u>	C	C
<u>Pennisetum polystachion</u>	C	A/C
<u>Phragmites karka</u>	C	A
<u>Saccharum spontaneum</u>	C	

Table 18. (continued)

SPECIES	Sasa	Atantano
HYDROCHARITACEAE		
<u>Enhalus acoroides</u>	C	
ORCHIDACEAE		
<u>Spathoglottis plicata</u>	C	C
PALME		
<u>Cocos nucifera</u>		C
<u>Nypa fruticans</u>	C	C
PANDANACEAE		
<u>Pandanus dubius</u>	C	
<u>P. tectorius</u>	C	C
AMARANTHACEAE		
<u>Alternanthera sessilis</u>	C	
BORAGINACEAE		
<u>Messerschmidia argentea</u>	C/R	
CASUARINACEAE		
<u>Casuarina equisetifolia</u>	C	C
COMBRETACEAE		
<u>Lumnitzera littorea</u>	A	
<u>Terminalia catappa</u>	C/R	
COMPOSITAE		
<u>Elephantopus mollis</u>	C	
<u>Mikania scandens</u>	C	A
<u>Pluchea indica</u>	C	C
CONVOLVULACEAE		
<u>Ipomoea aquatica</u>	C	
<u>I. pes-caprae</u>	C	

Table 18. (continued)

SPECIES	Sasa	Atantano
CUCURBITACEAE		
<u>Momordica charantia</u>	C	
EUPHORBIACEAE		
<u>Glochidion marianum</u>	C	C
GOODENIACEAE		
<u>Scaevola taccada</u>	C	C
HERNANDIACEAE		
<u>Hernandia sonora</u>	R	
LABIATAE		
<u>Hyptis capitata</u>		C
LAURACEAE		
<u>Cassytha filiformis</u>	C	C
LECYTHIADACEAE		
<u>Barringtonia asiatica</u>	C	C
LEUGUMINOSAE		
<u>Cassia occidentalis</u>	R	
<u>Dalbergia candenatensis</u>	C/R	A
<u>Delonix regia</u>		R
<u>Desmanthus virgatus</u>	C	C
<u>Entada pursaetha</u>	C	
<u>Leucaena leucocephala</u>	A/C	C
<u>Mimosa pudica</u>	C	
<u>Pithecellobium dulce</u>	C	C
<u>Sesbania cannabina</u>	C	
LYTHRACEAE		
<u>Pemphis acidula</u>	R	

Table 18. (continued)

SPECIES	Sasa	Atantano
MALVACEAE		
<u>Hibiscus tiliaceus</u>	C	A
<u>Sida acuta</u>	C	
<u>Thespesia populnea</u>	C	C
<u>Urena lobata</u>	R	
MELIACEAE		
<u>Xylocarpus moluccensis</u>	C/R	R
OLEACEAE		
<u>Jasminum marianum</u>	C	C
PASSIFLORACEAE		
<u>Passiflora foetida</u> v. <u>hispida</u>	C	C
<u>P. suberosa</u>	C	C
POLYGALACEAE		
<u>Polygala paniculata</u>	C	C
RHAMNACEAE		
<u>Colubrina asiatica</u>	C	C
RHIZOPHORACEAE		
<u>Brugiera gymnorhiza</u>	C	R
<u>Rhizophora apiculata</u>	C	A
<u>R. mucronata</u>	A	C
RUBIACEAE		
<u>Morinda citrifolia</u>	R	C
RUTACEAE		
<u>Triphasia trifolia</u>	C	C/R
STERCULIACEAE		
<u>Heritiera littoralis</u>	R	
<u>Melochia villosissima</u>		R
VERBENACEAE		
<u>Avicennia alba</u>	A	AA
<u>Clerodendrum inerme</u>	C	C

Table 19. Checklist of algae observed in east Sasa Bay and Atantano mangroves.

SPECIES	Comments
CYANOPHYTA	
<u>Microcoleus lyngbyaceus</u>	on prop roots
<u>Schizothrix</u> sp.	on prop roots
CHLOROPHYTA	
<u>Avrainvillea obscura</u>	mud/sand sub- stratum

Table 20. Checklist of common mangrove associated macroinvertebrates observed in east Sasa Bay area. * = abundant. (adapted from Univ. Guam Mar. Lab., 1977).

SPECIES

MOLLUSCA

GASTROPODA

Cerithium sp.
Chicoreus penchinati
 *Littorina scabra

BIVALVIA

Gafrarium tumidum
 *Saxostrea mordax
 *Septifer bilocularis

ANNELIDA

POLYCHAETA

Sebellastarte indica

ARTHROPODA

CRUSTACEA

*Cardisoma sp.
Clibinarius striolatus
Pachygrapsus planifrons
P. plicatus
Thalamita crenata
 *Uca chlorophthalmus crassipes
Uca vocans

AREA VI:
OROTE SUBMARINE CLIFFS

The cliffline extending from the tip of Orote Peninsula to approximately Neye Island exhibits a unique physiographic feature of Guam. The familiar fringing reefs and cut benches are replaced by submarine cliffs and terraces (Fig. 11). Despite inaccessibility other than by boat, this pristine area is popular with SCUBA divers and fisherman. Throughout the summer months the northwest swell is small. Strong currents, depth and scouring make this area less rich and diverse than other communities studied.

The selected area measures approximately 500 meters along the coast from the "Blue Hole" and cliff line tripod, at the northwest, to a white fracture zone in the cliffs, to the southeast. The entire coastal land is part of the U. S. Naval, Apra Harbor Reservation. The study area chosen is well beyond the 1000 meter radius required for the proposed U. S. Naval Ammunition Wharf east of Orote Island and should not be affected by it.

No previous survey has been done for the Orote submarine cliff area with respect to the marine biotic community. A complete physiographic description of the area is given by Randall and Holloman (1974). The following summary is taken in part from their report.

The cliffs drop vertically to the first submarine terrace at a depth of 15-20 meters. The narrow terrace varies in width from 20-45 meters at which point another submarine cliff drops to the second terrace at a depth of approximately 80 meters (Fig. 12). Sea level nips are prominent along most of the cliff line and in several places large blocks have broken off from the cliff and are found on the terrace below. Some of these are 10 meters or more in relief.

A large hole approximately 7 meters in diameter known as the "Blue Hole" opens on the first terrace at approximately 18 meters. The shaft extends vertically to approximately 80 meters with a window opening at 35 meters.

The Guam Environmental Protection Agency water quality classification for this area is "A", recreational use. No point source discharges are known for the immediate area (Shidel, 1977).

For purposes of this report three physiographic zones were recognized: (1) the slope beginning at the sea level nip and extending to the first terrace, (2) terrace and (3) the blue hole. The true submarine cliff was only partially examined as the depth quickly exceeded the safe limit for SCUBA diving. Tables 21-24 list the organisms observed during the study.




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Apra Harbor

Orote Island

Orote Peninsula

N
1:4800

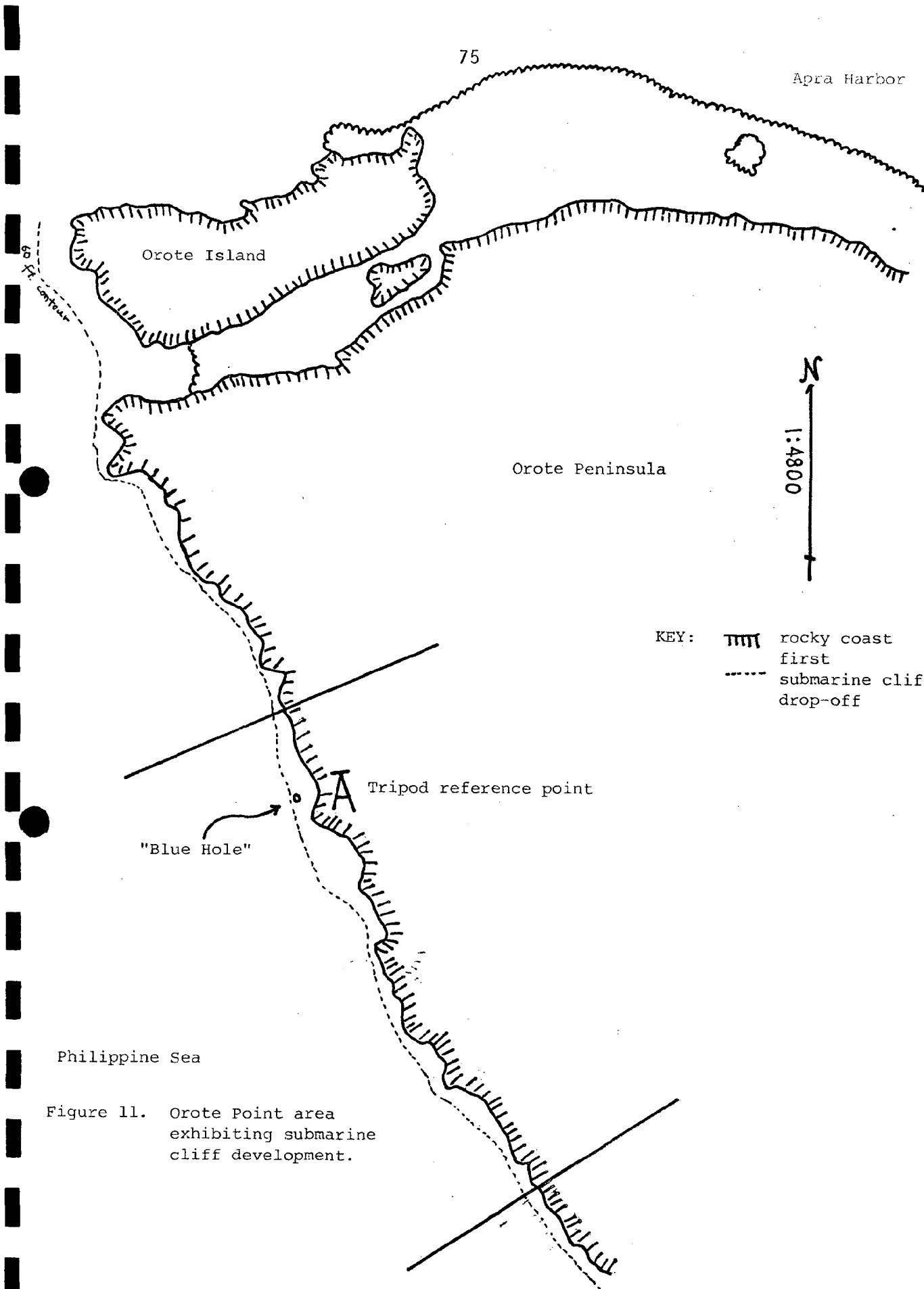
KEY:  rocky coast
 first
 submarine cliff drop-off

Tripod reference point

"Blue Hole"

Philippine Sea

Figure 11. Orote Point area exhibiting submarine cliff development.



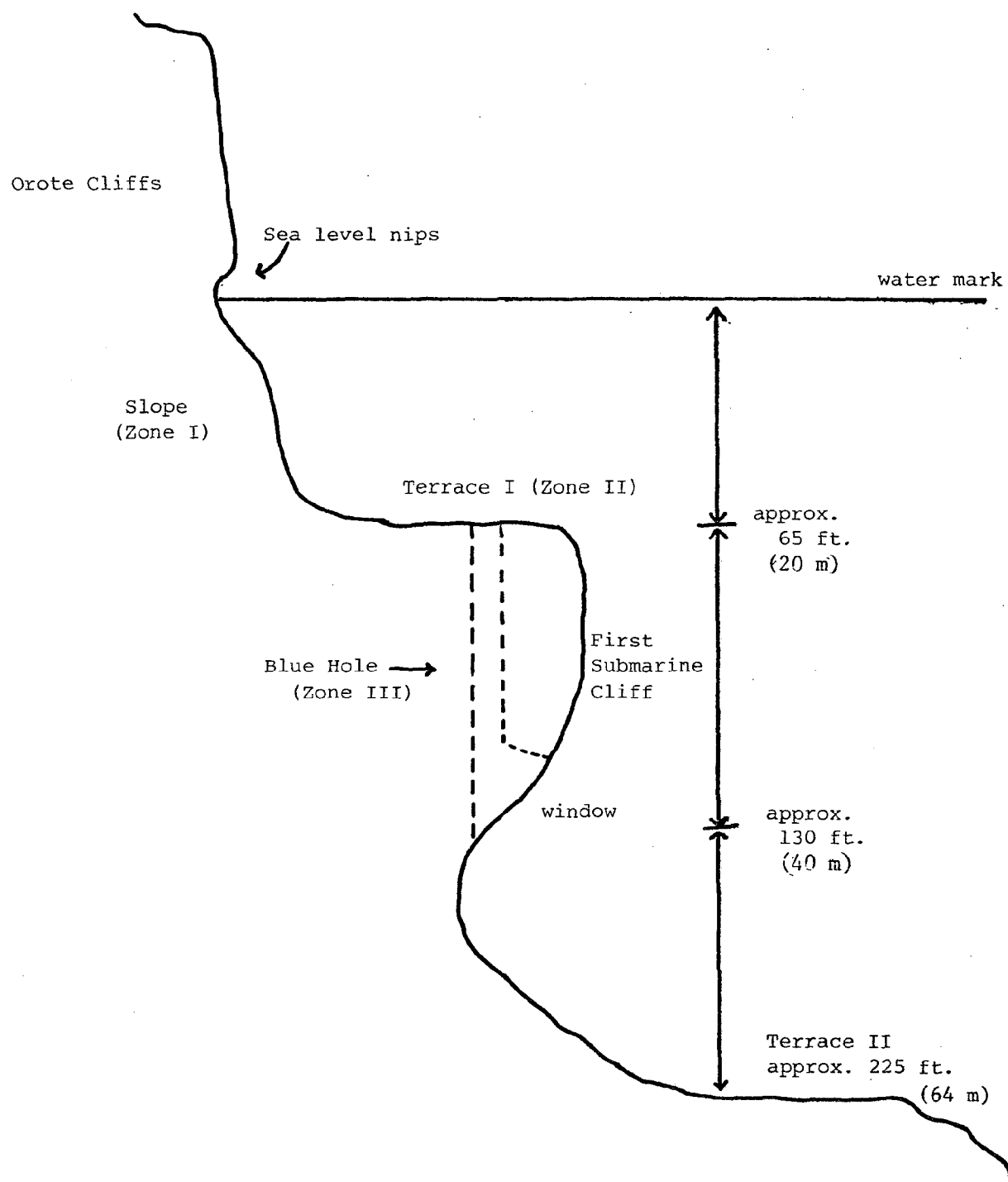


Figure 12. Profile of Orote Cliff area showing major physiographic transitions. (Not to scale)

Coral cover was minimal. No extensive community development including ridges, knobs or pinnacles was observed. The upper slope and most of the terrace floor consisted of scattered small Pocillopora colonies. In more protected habitats around fallen blocks and larger rubble, a much richer coral community was evident. Acropora and Porites colonies were common along with patches of soft corals and crinoids. Diversity was moderate with no single genus dominating. The "Blue Hole" provides a cavelike habitat with subdued light and little water movement. Deep water and cryptic corals were moderately abundant.

Turf algae dominated the slope and terrace areas. In the wave agitated nip zone Gelidium, Ectocarpus and Cheilosporum species were dominant. Further down the slope, Schizothrix, Turbinaria, Dictyota and Padina species were visually dominant. In protected areas, many more genera were observed.

In contrast to the slope and terrace zones, the "Blue Hole" was virtually lined with both turf and macroalgae. Schizothrix mexicana in a variety of forms along with small clumps of Padina minor and Dictyota divaricata provided the backdrop for the striking presence of Tydemannia expeditionis in both life forms and Rhipilia orientalis, displaying large velvety thalli. These two common algae were tremendously abundant and beautiful. The tiny Caulerpa filicoides was also abundant.

Despite the rather barren topography and lack of typical coral reef habitats, many plankton feeding fish such as pomacentrids were observed. On the terrace margins transient pelagic predators including sharks are frequently seen. Skipjack, large snappers and groupers are relatively common though they were not observed.

Various urchins and gastropods were evenly distributed throughout the area. The small crab, Grapsus grapsus was common along the nip area. The spiny lobster Panulirus sp. and the crab Carpilius maculatas have been observed by the author on night dives.

The flat and brilliantly purple coral, Pachyclavularia violacea was observed in semi-protected areas along the submarine terrace. This species has not been seen elsewhere on Guam to date.

CONCLUSIONS AND RECOMMENDATIONS

The submarine cliffs along the Orote Peninsula are a unique physiographic feature on Guam. The area selected is typical of the entire section and while a more southern representative site could be substituted, there are no alternative sites around the island. No threatened or endangered species have been reported in this area. Barring a major oil spill or other catastrophe, the nature of this area with its strong currents reduces the probability of serious environmental alteration.

The following recommendations are suggested for the Orote submarine cliff area:

- 1) that this area or a section of it be established as a natural sanctuary in which no coral harvesting, net fishing or other such activity be allowed.
- 2) that SCUBA diving and spear fishing activities be retained.
- 3) that no landfill waste or garbage be dumped along the cliffs.

Table 21. Checklist of benthic algae observed at the Orote Submarine Cliffs and Blue Hole area.

SPECIES	ZONES		
	1	2	4
CYANOPHYTA (blue-green algae)			
<u>Calothrix</u> sp.	x		
<u>Microcoleus lyngbyaceus</u>	x	x	x
<u>Schizothrix calcicola</u>	x	x	x
<u>S. mexicana</u>		x	x
CHLOROPHYTA (green algae)			
<u>Caulerpa filicoides</u>			x
<u>C. racemosa</u>		x	
<u>Chlorodesmis fastigiata</u>	x	x	
<u>Dictyosphaeria versluysii</u>	x	x	
<u>Halimeda opuntia</u>	x	x	x
<u>Neomeris annulata</u>	x	x	x
<u>Rhipilia orientalis</u>			xx
<u>Tydemannia expeditionis</u>			xx
<u>Valonia ventricosa</u>	x	x	
<u>Udotea geppi</u>		x	x
PHAEOPHYTA (brown algae)			
<u>Dictyota bartayresii</u>		x	
<u>D. divaricata</u>	x	x	x
<u>Ectocarpus breviarticulatus</u>	x		
<u>Hydroclathrus clathratus</u>	x		
<u>Padina minor</u>	x		
<u>P. jonesii</u>		x	x
<u>Turbinaria ornata</u>	x		
RHODOPHYTA (red algae)			
<u>Actinotrichia fragilis</u>	x		
<u>Cheilosporum</u> sp.	x		
<u>Desmia hornemanni</u>		x	
<u>Galaxaura oblongata</u>		x	x
<u>Gelidium pusillum</u>	x		
<u>Halymenia durvillaei</u>		x	
<u>Polysiphonia</u> sp.	x		
<u>Pterocladia parva</u>	x	x	
<u>Tolypiocladia glomerulata</u>	x	x	

Table 22. Checklist of corals observed at the Orote Submarine Cliffs and Blue Hole area.

SPECIES	ZONES	
	2-3	4
ANTHOZOA		
POCILLOPORIDAE		
<u>Pocillopora verrucosa</u>	x	
<u>P. sp. 1</u>	x	
<u>P. sp. 2</u>	x	
ACROPORIDAE		
<u>Acropora sp. 1</u>	x	
<u>A. sp. 2</u>	x	
<u>A. sp. 3</u>	x	
<u>Astreopora sp. 1</u>	x	
<u>A. sp. 2</u>	x	
<u>Montipora ehrenbergii</u>	x	
<u>M. foveolate</u>	x	
<u>M. sp. 1</u>	x	x
<u>M. sp. 2</u>	x	x
AGARICIIDAE		
<u>Pachyseris sp.</u>		x
<u>Pavona sp.</u>	x	x
PORTIDAE		
<u>Porites sp. 1</u>	x	x
<u>P. sp. 2</u>	x	
FAVIIDAE		
<u>Favia sp.</u>		x
<u>Goniastrea retiformis</u>	x	
<u>Leptastrea purpurea</u>	x	
<u>L. sp.</u>		x
<u>Cyphastrea sp.</u>	x	
<u>Diploastrea heliopora</u>	x	
MUSSIDAE		
<u>Lobophyllia sp.</u>	x	
CLAVULARIIDAE		
<u>Pachyclavularia violacea</u>	x	

Table 23. Checklist of common macroinvertebrates observed at the Orote Submarine Cliffs and Blue Hole area.

SPECIES	ZONES 1-3
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MOLLUSCA

GASTROPODA

Conus miles
C. rattus
C. sponsalis
Cypraea arabica
C. caputserpentis
C. isabella
C. poraria
Drupa grossularia
D. morum
D. ricinus
Patella sp.
Vasum ceramicum
V. turbinellus

ECHINODERMATA

ECHINOIDEA

Echinometra mathaei
Echinostrephus aciculatus
Echinothrix calamaris
Heterocentrotus mamillatus

ARTHROPODA

CRUSTACEA

Carpilius maculatus
Grapsus grapsus
Panulirus sp.

Table 24. Checklist of fishes observed at the Orote Submarine Cliffs and Blue Hole area.

SPECIES	ZONES		
	1	2	3
ACANTHURIDAE			
<u>Acanthurus glaucopareius</u>	x	x	
<u>A. lineatus</u>	x		
<u>A. nigrofuscus</u>		x	
<u>A. olivaceus</u>		x	
<u>A. triostegus</u>	x	x	
<u>Ctenochaetus striatus</u>	x	x	
<u>Naso lituratus</u>		x	
APOGONIDAE			
<u>Apogon fraenatus</u>			x
BALISTIDAE			
<u>Balistes bursa</u> (=Sufflamen bursa)		x	
<u>B. chrysopterus</u> (=Sufflamen chrysoptera)		x	
<u>Melichthys niger</u>		x	
<u>M. vidua</u>		x	
<u>Rhinecanthus rectangulus</u>		x	
BLENNIIDAE			
<u>Aspidontus taeniatus</u>		x	
<u>Meiacanthus atrodorsalis</u>	x	x	
"Blenny" sp. 1			x
"Blenny" sp. 2			x
CHAETODONTIDAE			
<u>Chaetodon ephippium</u>		x	
<u>C. mertensii</u>			x
<u>Forcipiger longirostris</u>		x	
<u>Heniochus chrysostomus</u>			x
<u>Holacanthus trimaculatus</u>			x
<u>Pygoplites diacanthus</u>			x
CIRRHITIDAE			
<u>Neocirrhites armatus</u>		x	
<u>Paracirrhites forsteri</u>		x	
GOBIIDAE			
<u>Nemateleotris magnificus</u>		x	

Table 24. (continued)

SPECIES	ZONES		
	1	2	3
HOLOCENTRIDAE			
<u>Adioryx</u> sp.			x
<u>Myripristis</u> sp.			x
KYPHOSIDAE			
<u>Kyphosus</u> sp.	x		
LABRIDAE			
<u>Chaelinus rhodochrous</u>		x	
<u>Epibulus insidiator</u>		x	
<u>Labroides dimidiatus</u>		x	
<u>Thalassoma lutescens</u>		x	
<u>T. purpureum</u>	x		
<u>T. quinquevittata</u>		x	
LUTJANIDAE			
<u>Aphareus furcatus</u>	x	x	
<u>Plectorhincus</u> sp.			x
MULLIDAE			
<u>Parupeneus multifasciatus</u>		x	
POMACENTRIDAE			
<u>Chromis acares</u>			x
<u>C. elerae</u>			x
<u>Dascyllus trimaculatus</u>		x	
<u>Glyphidodontops leucopomus</u>	x		
<u>G. traceyi</u>			x
<u>Plectroglyphidodon imparipennis</u>	x		
<u>Pomacentrus melanopterus</u>	x		
<u>P. vaiuli</u>		x	
<u>Pomachromis guamensis</u>			x
SCARIDAE			
<u>Scarus ghobban</u>		x	
<u>S. sordidus</u>		x	
<u>S. venosus</u>		x	

Table 24. (continued)

SPECIES	ZONES		
	1	2	3
SERRANIDAE			
<u>Anyperodon leucogrammicus</u>			x
<u>Cephalopholis argus</u>			x
<u>C. urodelus</u>		x	
SYNGNATHIDAE			
"Syngnathid" sp.			x

AREA VII:
ANAE ISLAND PATCH REEF AND TERRACE

Anae Island, with its associated patch reef and terrace, is located just south of Nimitz Beach Park, approximately one kilometer offshore (Fig. 13). The island and patch reef form a mini-barrier reef system which protects the inside (shoreward) submarine terrace from large swells and strong currents. The submarine terrace between the patch reef and adjacent fringing reef supports one of the richest and most diverse coral communities found in Guam's coastal waters. This pristine area is readily accessible by small boat from the shore and is a popular area for SCUBA diving and underwater photography.

No previous survey has been done for the Anae area with respect to the marine biotic community. A partial physiographic description of the area is given by Randall and Holloman (1974). The following is taken in part from their report.

Anae Island is one of eight islets located along the southwest coast of Guam, but is the only one not associated with the fringing reef. The western and northern exposures of the island and patch reef slope steeply to a 30 meter terrace while the eastern and southern exposures consist of a gently sloping terrace approximately 3-8 meters in depth. In these protected waters spectacular coral mounds, pinacles and ridges, with their associated ichthyofauna are separated by sandy floored channels and holes. The relief of these coral mounds is often 6-8 meters or more.

The Guam Environmental Protection Agency water rating for the Anae area is "AA" - conservation. No point source discharges have been identified for the immediate area (Shidel, 1977).

Much of the surface of the patch reef is exposed during low tides and was largely devoid of live corals. The surface consisted of coral-algal-shell debris with a fine veneer of turf algae. The area of primary interest was the shoreward edge and terrace zones previously described. Two reconnaissance visits were made. Organisms observed at the study site are listed in Tables 25-26.

The coral community along the inside patch reef edge consisted of smaller Acropora, Leptastrea and Porites colonies. Goniastrea retiformis was found in scattered patches. Sloping down towards the terrace, at a depth of 4-9 meters, the diversity and colony size increased tremendously. Huge Acropora palifera and hemispherical Porites colonies dominated creating a room and pillar effect in many places. Other notable species included Millepora platyphylla, Goniastrea pectinata, Leptoria phrygia and Pavona frondifera.

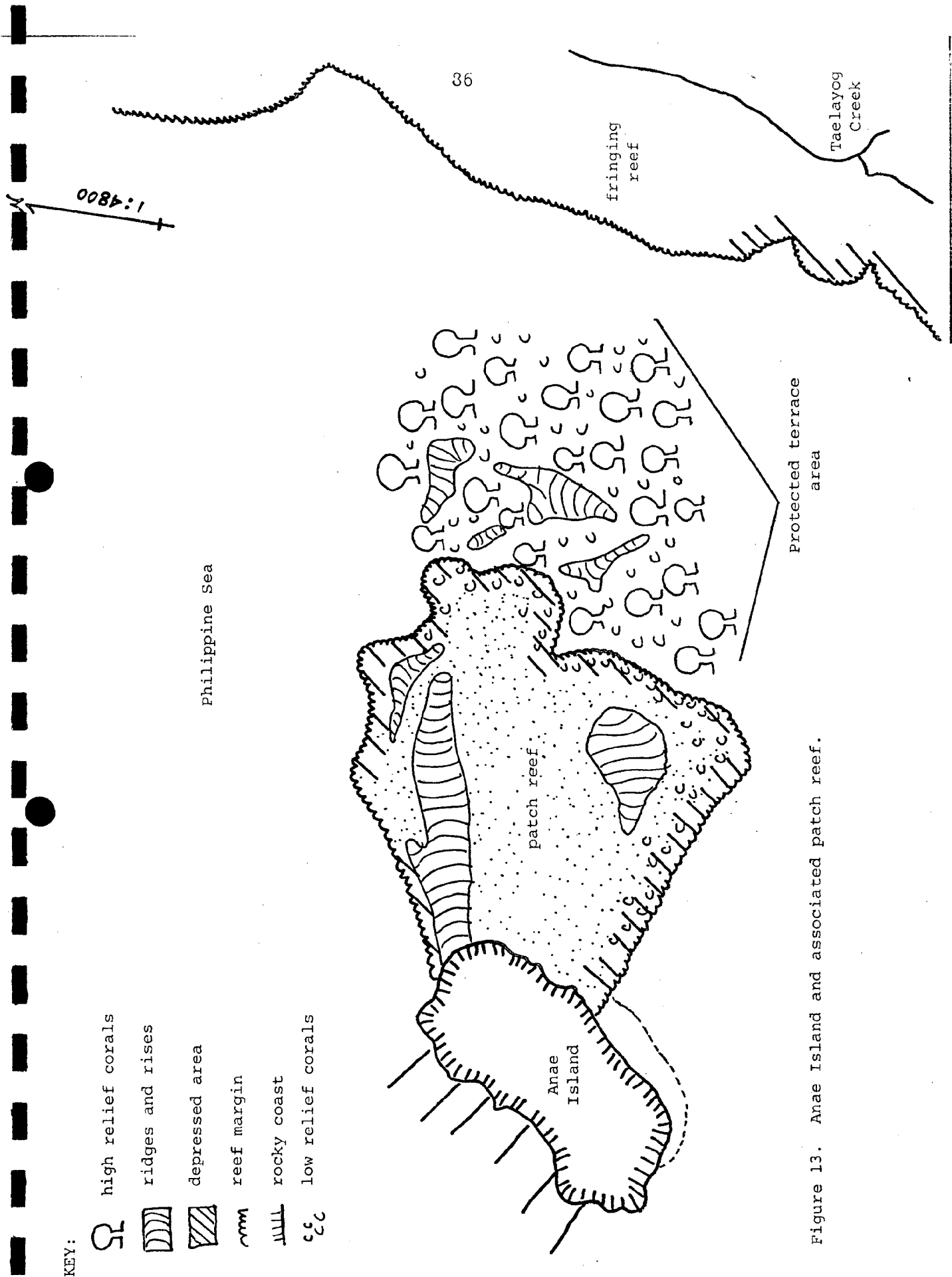


Figure 13. Anae Island and associated patch reef.

The algal community was moderately diverse with no single genus particularly dominant. Chlorodesmis fastigiata, Tydemannia expeditionis, Desmia hornemanni and Asparagopsis taxiformis species were common.

The fish community was very diverse which follows from the many habitats provided by the rich coral community. Typical reef associated pomacentrids and chaetodontids were abundant in addition to acanthurids, blennies and labrids.

No threatened or endangered species have been identified for this area.

CONCLUSIONS AND RECOMMENDATIONS

The beauty of the Anae area, with its pristine coral community and clear, protected waters, makes it an important preservation site for both scientific study and controlled recreational use. The area is readily accessible and a favorite spot for SCUBA diving and underwater photography.

The following recommendations are suggested for the Anae area:

- 1) that this area be established as a natural sanctuary in which no coral harvesting, fishing or other such activity be allowed.
- 2) that swimming, snorkeling and SCUBA diving activities be retained.
- 3) that mooring buoys be installed for boaters to avoid unnecessary coral breakage due to setting anchors.
- 4) that an underwater park with trails be developed.

Table 25. Checklist of benthic algae observed at Anae Island patch reef.

SPECIES

CYANOPHYTA (blue-green algae)

Anacystis sp.
Microcoleus lyngbyaceus
Schizothrix calcicola
S. mexicana

CHLOROPHYTA (green algae)

Boodlea composita
Caulerpa racemosa
Chlorodesmis fastigiata
Codium edule
Dictyosphaeria versluysii
Halimeda opuntia
Neomeris annulata
Tydemannia expeditionis
Udotea geppi

PHAEOPHYTA (brown algae)

Lobophora variegata
Sphacelaria tribuloides

RHODOPHYTA (red algae)

Actinotrichia fragilis
Amphiroa foliacea
A. fragilissima
Asparagopsis taxiformis
Ceramium sp.
Corallina sp.
Desmia hornemanni
Galaxaura marginata
G. oblongata
Gelidium divaricatum
Jania sp.
Liagora sp.
Polysiphonia sp.
Porolithon onkodes
Tolypocladia glomerulata

Table 26. Checklist of common macroinvertebrates observed at Anae Island patch reef.

SPECIES

MOLLUSCA

GASTROPODA

Cerithium nodulosum
C. sp.
Conus miles
C. rattus
C. striatus
Coralliophila violacea
Cypraea sp.
Sabia conica
Tectus pyramis
Thais armigera
Trochus niloticus
T. maculatus
Turbo argyrostomus
Vasum turbinellus

BIVALVIA

Tridacna maxima

ECHINODERMATA

ASTEROIDEA

Culcita novaeguineae
Linckia laevigata
L. multiflora

ECHINOIDEA

Diadema savignyi
Echinometra mathaei
Echinostrephus aciculatus
Echinothrix diadema
Toxopneustes gratilla

HOLOTHUROIDEA

Actinopyga echinites
Bohadschia argus
Holothuria atra
H. hilla
H. nobilis
Stichopus chloronotus

AREA VIII:
CETTI BAY

Cetti Bay (Fig. 14) is located on the southwest coast of Guam between Sella and Fouha Bays. The bay is extremely isolated and can be reached only by boat or a long hike. Route 4 overlooks the bay. The steep surrounding slopes and sandy beaches, combined with a diverse reef community, make Cetti Bay one of the most picturesque pristine marine communities on Guam.

No previous study has been conducted for Cetti Bay with respect to the marine biotic community. Randall and Holloman (1974) give a partial physiographic description of the area. A summary of their findings are incorporated below.

The Guam Environmental Protection Agency water quality rating for Cetti Bay is "AA" -conservation. No point source discharges are known for the area (Shidel, 1977).

The study area was divided into two broad zones: (1) reef flats and (2) margin, face and terrace. Tables 27-30 list those organisms observed in the area.

The reef flat is continuous around the bay with the exception of two breaks occurring at the river mouths. The platforms are narrow (15-20 meters) with no moat or algal ridge development. At low tides they are typically exposed and therefore largely devoid of corals, though a rich algal community persists. A diverse macroinvertebrate community was also evident. The holothurians Holothuria atra and Actinopyga echinites were abundant. In addition, many large sea anemones, measuring a meter or more in diameter, were common along the shallower waters of the upper margin and terrace zones.

The reef margin, face and terrace were fairly uniform around the bay with the exception of a volcanic area on the north side. There, the margin is cut by irregular cracks and fissures. Some of the fissures were up to 6 meters deep and 2-3 meters wide.

The margin face typically extended down for 3-4 meters and then sloped to a tilted terrace zone averaging 4-10 meters deep. Beyond that point the sand floor of the bay began. The floor of the bay was not investigated.

The algal and coral communities in Zone 2 were very rich and diverse. In addition to low relief colonies along the upper margin face, massive columns and mounds of Porites characterized the adjacent terrace. Large colonies of Montipora and Acropora were common in addition to Galaxia, Cyphastrea, Pavona and Goniastrea species.

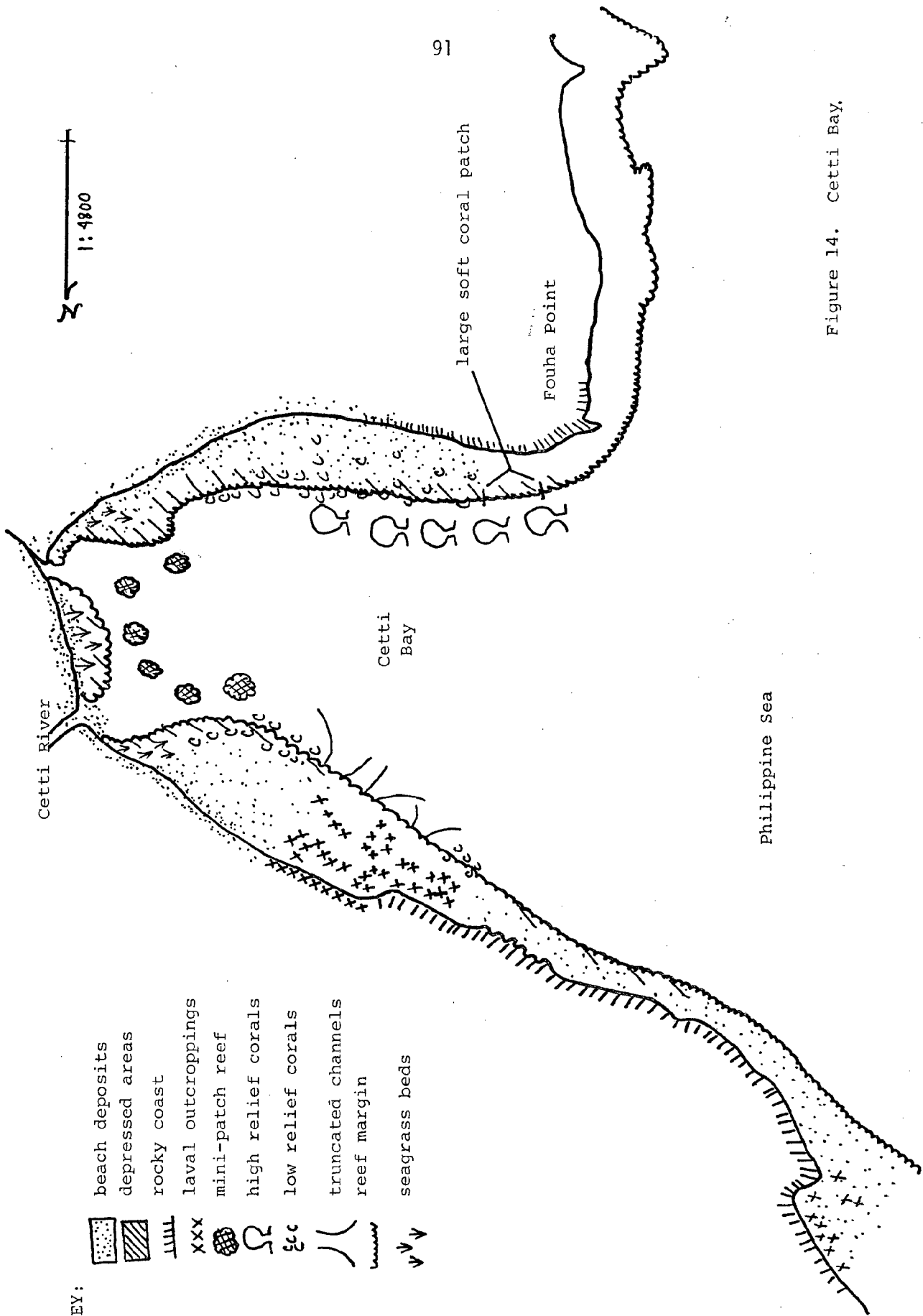


Figure 14. Cetti Bay.

Of particular interest was a huge bed (6 meters in diameter) of the soft corals Sinularia and Lobophyton species. This patch is located midway out on the south side.

The algal genera, Caulerpa and Halimeda, were particularly abundant along the lower margin. Asparagopsis taxiformis was observed only on the north side of the bay. The seagrass Enhalus acoroides was found in small patches along the east side of the inner bay reef flat. In all, forty-three genera of benthic algae were observed.

The fish community was sparse in the inner bay where silt content was high and visibility low. In general, however, visibility was excellent throughout most of the bay. Many pomacentrids and chaetodontids were present in addition to acanthurids, blennies and other reef associated fishes.

No threatened or endangered species have been identified for Cetti Bay.

CONCLUSIONS AND RECOMMENDATIONS

Cetti Bay is one of the most picturesque pristine areas on the island, both above and below the water. Though isolated, its protected waters make it a favorite spot for divers, boaters and fisherman.

The following recommendations are suggested for Cetti Bay:

- 1) that this area be established as a natural sanctuary in which no coral harvesting, fishing or other such activity be allowed.
- 2) that swimming, snorkeling and SCUBA diving activities be retained.
- 3) that mooring buoys be installed for boaters to avoid unnecessary coral breakage due to setting anchors.
- 4) that a "Thermos law" be enforced to halt beverage can litter.

Table 27. Checklist of benthic algae observed at Cetti Bay.

SPCIES	Reef flat	Margin & Face
CYANOPHYTA (blue-green algae)		
<u>Microcoleus lyngbyaceus</u>	x	x
<u>Schizothrix calcicola</u>	x	
<u>S. mexicana</u>	x	
CHLOROPHYTA (green algae)		
<u>Boodlea composita</u>	x	
<u>Bryopsis pennata</u>		x
<u>Caulerpa cupressoides</u>	x	x
<u>C. filicoides</u>		x
<u>C. racemosa</u>		x
<u>C. serrulata</u>	x	x
<u>Codium edule</u>		x
<u>Dictyosphaeria versluysii</u>	x	x
<u>Enteromorpha clathrata</u>	x	
<u>Halimeda gigas</u>		x
<u>H. macroloba</u>	x	x
<u>H. opuntia</u>	x	x
<u>Neomeris annulata</u>		x
<u>Tydemannia expeditionis</u>		x
<u>Udotea argentea</u>	x	x
PHAEOPHYTA (brown algae)		
<u>Dictyota bartayresii</u>		x
<u>D. divaricata</u>		x
<u>D. friabilis</u>		x
<u>Hydroclathrus clathratus</u>	x	x
<u>Lobophora variegata</u>	x	x
<u>Padina minor</u>	x	x
<u>Sphacelaria tribuloides</u>	x	x
<u>Turbinaria ornata</u>	x	
RHODOPHYTA (red algae)		
<u>Actinotrichia fragilis</u>		x
<u>Amphiroa foliacea</u>	x	x
<u>A. fragilissima</u>	x	x
<u>Asparagopsis taxiformis</u>	*x	x
<u>Ceramium gracillimum</u>	x	x
<u>C. mazatlanense</u>		x
<u>C. sp.</u>		x

*Alga found on north reef flat only.

Table 27. (continued)

SPECIES	Reef flat	Margin & Face
<u>Cheilosporum</u> sp.		x
<u>Corallina</u> sp.		x
<u>Desmia hornemanni</u>		x
<u>Galaxaura filamentosa</u>		x
<u>G. marginata</u>		x
<u>G. oblongata</u>		x
<u>Gelidium crinale</u>	x	x
<u>G. pusillum</u>	x	x
<u>Gracilaria arcuata</u>	x	
<u>Gracilaria</u> sp.	x	
<u>Hypnea</u> sp.	x	x
<u>Jania capillacea</u>	x	
<u>J. tenella</u>		x
<u>Liagora</u> sp.		x
<u>Peyssonelia rubra</u>		x
<u>Pterocladia parva</u>		x
<u>Tolypiocladia glomerulata</u>		x
SPERMATOPHYTA (seagrasses)		
<u>Enhalus acoroides</u>	x	

Table 28. Checklist of corals observed at Cetti Bay.

SPECIES	North Bay	South Bay
ANTHOZOA		
ASTROCOENIIDAE		
<u>Stylocoeniella armata</u>	x	x
THAMINASTERIIDAE		
<u>Psammocora</u> sp.	x	x
POCILLOPORIDAE		
<u>Stylophora mordax</u>	x	x
<u>Pocillopora damicornis</u>		x
<u>P. elegans</u>	x	x
<u>P. setchelli</u>	x	x
<u>P. verrucosa</u>	x	
<u>P. sp. 1</u>	x	x
<u>P. sp. 2</u>	x	
ACROPORIDAE		
<u>Acropora formosa</u>	x	
<u>A. irregularis</u>		x
<u>A. nana</u>	x	x
<u>A. nasuta</u>	x	
<u>A. histrix</u>	x	
<u>A. palifera</u>	x	
<u>A. sp. 1</u>	x	
<u>A. sp. 2</u>		x
<u>A. sp. 3</u>		x
<u>A. sp. 4</u>		x
<u>Astreopora</u> sp.		x
<u>Montipora</u> sp. 1	x	
<u>M. sp. 1</u>	x	
<u>M. sp. 2</u>		x
<u>M. sp. 3</u>		x
<u>M. sp. 4</u>		x
<u>M. sp. 5</u>	x	x
<u>M. sp. 6</u>	x	
<u>M. sp. 7</u>	x	
AGARICIIDAE		
<u>Goniopora</u> sp. 1	x	x
<u>G. sp. 1</u>	x	

Table 28. (continued)

SPECIES	North Bay	South Bay
<u>Porites andrewsi</u>	x	
<u>Porites reticulosa</u>	x	
<u>P. lutea</u>		x
<u>P. sp. 1</u>		x
<u>P. sp. 2</u>		x
<u>P. sp. 3</u>		x
<u>P. sp. 4</u>	x	
<u>P. sp. 5</u>	x	
FAVIIDAE		
<u>Favia speciosa</u>		x
<u>F. sp. 1</u>		x
<u>F. sp. 2</u>	x	x
<u>Goniastrea retiformis</u>	x	x
<u>G. sp. 1</u>		x
<u>Platygyra rustica</u>	x	x
<u>P. sinensis</u>	x	x
<u>Leptoria sp.</u>	x	x
<u>Leptastrea purpurea</u>	x	x
<u>L. sp.</u>		x
<u>Cyphastrea sp.</u>	x	x
<u>Echinopora sp.</u>		x
<u>Diploastrea heliopora</u>	x	
OCULINIDAE		
<u>Galaxea sp.</u>	x	x
MUSSIDAE		
<u>Lobophyllia hemprichii</u>	x	x
<u>L. sp.</u>	x	x
<u>Acanthastrea echinata</u>		x
HELIOPORIDAE		
<u>Heliopora coerulea</u>		x
TUBIPORIDAE		
<u>Tubipora musica</u>	x	x
ALCYONIIDAE		
<u>Alcyonium utinomii</u>	x	
<u>Sarcophyton glaucum</u>		x

Table 28. (continued)

SPECIES	North Bay	South Bay
<u>Sinularia densa</u>	x	
<u>S. maxima</u>	x	
<u>S. polydactyla</u>		x
<u>S. sp. 1</u>	x	x
<u>S. sp. 2</u>		x
ZOANTHIDAE		
<u>Zoanthus</u> sp.	x	x
HYDROZOA		
MILLEPORIDAE		
<u>Millepora exaesa</u>	x	x
<u>M. platyphylla</u>	x	x

Table 29. Checklist of common macroinvertebrates observed at Cetti Bay.

SPECIES	
PORIFERA	CEPHALOPODA
<u>Cinachya australiensis</u>	<u>Octopus sp.</u>
MOLLUSCA	ECHINODERMATA
AMPHINEURA	ASTEROIDEA
Unknown sp.	<u>Linckia lavegata</u>
GASTROPODA	ECHINOIDEA
<u>Astraea rhodostoma</u>	<u>Diadema savignyi</u>
<u>Bursa bufonia</u>	<u>Echinometra mathaei</u>
<u>Cerithium nodulosum</u>	<u>Echinostrephus aciculatus</u>
<u>C. sp. 1</u>	<u>Echinothrix calamaris</u>
<u>C. sp. 2</u>	<u>E. diadema</u>
<u>Chicoreus penchinati</u>	
<u>Conus chaldeus</u>	HOLOTHUROIDEA
<u>C. lividus</u>	<u>Actinopyga echinites</u>
<u>C. miles</u>	<u>Holothuria atra</u>
<u>C. rattus</u>	<u>Stichopus chloronotus</u>
<u>C. sponsalis</u>	
<u>Coralliophilla violacea</u>	OPHIUROIDEA
<u>Cypraea arabica</u>	<u>Ophiothrix sp.</u>
<u>C. caputserpentis</u>	
<u>C. carneola</u>	ARTHROPODA
<u>C. isabella</u>	ANOMURA
<u>C. moneta</u>	<u>Calcinus latens</u>
<u>C. proaria</u>	<u>Clibinarius humulis</u>
<u>Drupella cornus</u>	
<u>Drupa ricinus</u>	BRACHYURA
<u>Morula granata</u>	<u>Calappa calappa</u>
<u>M. uva</u>	<u>Carpilius maculatus</u>
<u>Nerita plicata</u>	<u>Etisus dentatus</u>
<u>N. sp.</u>	<u>Grapsus grapsus</u>
<u>Patella sp. 1</u>	<u>Percnon sp.</u>
<u>P. sp. 2</u>	<u>Thalamita sp.</u>
<u>Sabia conica</u>	
<u>Strombus sp.</u>	
<u>Thais armigera</u>	
<u>Trochus niloticus</u>	
<u>Vasum turbinellus</u>	
BIVALVIA	
<u>Grafrarium sp.</u>	
<u>Septifer bilocularis</u>	
<u>Tridacna maxima</u>	

Table 30. Checklist of fishes observed at Cetti Bay.

SPECIES	North Bay	South Bay
ACANTHURIDAE		
<u>Acanthurus glaucopariens</u>	x	x
<u>A. lineatus</u>	x	x
<u>A. nigrofuscus</u>	x	x
<u>A. triostegus</u>		x
<u>Ctenochaetus striatus</u>	x	x
<u>Naso lituratus</u>	x	x
<u>N. sp.</u>	x	x
<u>Zebrasoma flavescens</u>		x
<u>Z. scopas</u>		x
APHAREIDAE		
<u>Aphareus furcatus</u>	x	x
APOGONIDAE		
<u>Apogon sp.</u>	x	
<u>Paramia quinquelineata</u>	x	
AULOSTOMIDAE		
<u>Aulostomus chinensis</u>		x
BALISTIDAE		
<u>Balistapus undulatus</u>	x	
<u>Balistes bursa (=Sufflamen bursa)</u>	x	
<u>B. chrysopterus (=S. chrysoptera)</u>		x
<u>Rhinecanthus rectangulus</u>	x	
BLENNIIDAE		
<u>Cirripectes variolosus</u>		x
<u>Meiacanthus atrodorsalis</u>	x	x
<u>Plagiotremus rhinorhynchus</u>		x
<u>P. tapeinosoma</u>		x
CANTHIGASTERIDAE		
<u>Canthigaster bennetti</u>		x
<u>C. solandri</u>	x	x
CHAETODONTIDAE		
<u>Centropyge flavissimus</u>		x

Table 30. (continued)

SPECIES	North Bay	South Bay
<u>Chaetodon auriga</u>		x
<u>C. bennetti</u>		x
<u>C. citrinellus</u>	x	x
<u>C. ephippium</u>	x	x
<u>C. lineolatus</u>	x	x
<u>C. lunula</u>	x	x
<u>C. mertensii</u>		x
<u>C. ornatissimus</u>	x	x
<u>C. punctato-fasciatus</u>		x
<u>C. quadrimaculatus</u>	x	x
<u>C. reticulatus</u>	x	x
<u>C. trifascialis</u> (<u>Megaprotodon strigangulus</u>)	x	x
<u>C. ulietensis</u>	x	x
<u>C. unimaculatus</u>	x	x
<u>Forcipiger</u> sp.		x
<u>Heniochus varius</u>	x	x
<u>Pygoplites diacanthus</u>		x
CIRRHITIDAE		
<u>Paracirrhites arcatus</u>		x
GOBIIDAE		
<u>Eviota</u> sp.		x
<u>Cryptocentrus</u> sp.	x	
<u>Ptereleotris tricolor</u>	x	
<u>Valenciennaea strigata</u>	x	
<u>Goby</u> sp. 1		x
<u>Goby</u> sp. 2		x
HOLOCENTRIDAE		
<u>Adioryx spinifer</u>		x
<u>A.</u> sp.		x
<u>Myripristis</u> sp. 1		x
<u>M.</u> sp. 2		x
<u>M.</u> sp. 3	x	
LABRIDAE		
<u>Anampses caeoruleapunctatus</u>	x	x
<u>Bodianus axillaris</u>	x	
<u>Cheilinus rhodochrous</u>	x	x
<u>C. trilobatus</u>	x	x
<u>C.</u> sp.		x
<u>Cymolutes lecluse</u>	x	
<u>Epibulus insidiator</u>		x

Table 30. (continued)

SPECIES	North Bay	South Bay
<u>Gomphosus varius</u>	x	x
<u>Halichoeres hortulanus</u> (=H. <u>centiquadrus</u>)	x	x
<u>H. margaritaceus</u>		x
<u>H. marginatus</u>	x	x
<u>H. nebulosus</u>		x
<u>H. trimaculatus</u>	x	x
<u>H. sp.</u>	x	
<u>Hemigymnus fasciatus</u>		x
<u>H. melapterus</u>		x
<u>Labroides bicolor</u>		x
<u>L. dimidiatus</u>	x	x
<u>Macropharyngodon meleagris</u>	x	x
<u>Stethojulis bandanensis</u>	x	x
<u>Thalassoma hardwickei</u>	x	x
<u>T. lunare</u>		x
<u>T. purpureum</u>	x	x
<u>T. quinquevittata</u>	x	x
<u>T. sp.</u>	x	
LUTJANIDAE		
<u>Caesio sp.</u>	x	
<u>Lutjanus fulvus</u>		x
<u>L. kasmira</u>		x
<u>L. vaigiensis</u>	x	x
<u>L. sp.</u>		x
MONACANTHIDAE		
<u>Amanses carolae</u>	x	x
<u>Oxymonacanthus longirostris</u>	x	x
MULLIDAE		
Mullet sp.		x
MUGILOIDIDAE		
<u>Parapereis sp.</u>		x
MULLIDAE		
<u>Mulloidichthys samoensis</u>	x	x
<u>Parupeneus barberinus</u>		x
<u>P. bifasciatus</u>		x
<u>P. cyclostomus</u>	x	x
<u>P. trifasciatus</u>	x	x
<u>P. sp.</u>	x	

Table 30. (continued)

SPECIES	North Bay	South Bay
NEMIPTERIDAE		
<u>Scolopsis cancellatus</u>	x	
OSTRACIONTIDAE		
<u>Ostracion meleagris</u>	x	x
<u>O. sp.</u>	x	
PEMPHERIDAE		
<u>Pempheris oualensis</u>	x	x
POMACENTRIDAE		
<u>Abudefduf coelestinus</u>	x	x
<u>A. saxatilis</u>		x
<u>A. sordidus</u>		x
<u>Amblyglyphidodon curacao</u>		x
<u>Amphiprion chrysopterus</u>		x
<u>A. melanopus</u>	x	x
<u>A. perideraion</u>	x	
<u>Chromis caerulea</u>	x	x
<u>C. margaritifer</u>	x	
<u>C. sp. 2</u>		x
<u>C. sp. 3</u>	x	
<u>Dascylus aruanus</u>	x	x
<u>D. reticulatus</u>	x	
<u>D. trimaculatus</u>	x	x
<u>Glyphidodontops leucopomus</u>	x	x
<u>G. sp.</u>		x
<u>Plectroglyphidodon dickii</u>	x	x
<u>P. johnstonianus</u>	x	
<u>P. lacrymatus</u>	x	x
<u>Pomacentrus vaiuli</u>	x	x
<u>P. sp.</u>		x
<u>Stegastes lividus</u>	x	
<u>S. nigricans</u>	x	
<u>S. sp.</u>	x	
<u>Pomacentrid sp.</u>	x	
SCARIDAE		
<u>Leptoscarus vaigiensis</u>		x
<u>Scarus sordidus</u>	x	x

Table 30. (continued)

SPECIES	North Bay	South Bay
SCORPAENIDAE		
<u>Synanceia verrucosa</u>	x	
SERRANIDAE		
<u>Epinephelus merra</u>		x
SIGANIDAE		
<u>Siganus argenteus</u>	x	
<u>S. spinus</u>		x
<u>S. vermiculatus</u>		x
SYNODONTIDAE		
<u>Synodus</u> sp.		x
TETRAODONTIDAE		
<u>Arothron nigropunctatus</u>		x
ZANCLIDAE		
<u>Zanclus cornutus</u>	x	x

AREA IX:
COCOS BARRIER REEFS AND LAGOON AREA

The Cocos area, a triangular barrier reef, lagoon and associated islands, is located just off the extreme southwest coast of Guam, opposite the village of Merizo. This complex area is unique to Guam, covering approximately 6.6 square kilometers and representing seven of the ten physiographic features outlined for this survey. These include barrier reefs, fringing reefs, patch reefs, barrier reef channels, mangroves, seagrass beds and estuaries. The increasing popularity of the Merizo coast and nearby Cocos Island, as a full time fishing and tourist operation makes preservation ever more urgent for this pristine area.

An extensive biological survey was prepared by Randall et al., (1975). Their report covers the above community types with particular emphasis given to the barrier reef, lagoon and channel communities. Quantitative physiographic as well as biotic data are included. The bibliography contains 41 references. The reader is strongly urged to consult the Randall et al. (1975) survey for an in-depth discussion.

Randall et al. (1975) divided the entire Cocos complex into three biotopes with multiple facies. Biotopes are defined as "primary ecological units including the entire complex of habitat, substrate, accretional and erosional processes, hydrologic factors and life associations." Facies are the smaller divisions made within biotopes. The following biotopes and associated facies were established for Cocos Lagoon:

Biotope I - This biotope includes the lagoon, barrier reef-flat platforms, and fringing reef-flat platforms.

Facies A - Barrier reef-flat platform.

Facies B - Shallow lagoon terrace or floor which forms a shelf extending from the lagoonward edge of the barrier reef and fringing reef-flat platforms to the 3 meter depth contour.

Facies C - Lagoon floor deeper than 3 meters.

Facies D - Patch reefs, mounds, and knolls which form distinct physiographic features on the lagoon floor.

Facies E - Nearshore shelf of fringing reef-flat platform which borders the landward side of Cocos Lagoon.

Biotope II - This biotope consists of the deep Mamaon and Manell Channels.

Facies A - Shallow channel margin shelves located at the upper margin of the channel slopes or walls.

Facies B - Channel slope located between the upper channel margin or shelf and the channel floor.

Facies C - Channel slopes which form steep rocky walls or submarine cliffs, located between the upper channel margin or shelf and channel floor.

Facies D - Cavernous parts of channel slopes and walls and the overhanging ceilings of submarine cliffs.

Facies E - Channel floor, usually composed of unconsolidated sediments.

Biotope III - This biotope consists of the terrestrial regions at Cocos Island and the small sand islet at its eastern end, Babe Island, and the landward border along Cocos Lagoon.

A discussion of each facies is beyond the scope of this report though the species lists reflect the biota of each one. A synopsis of the major biological findings in Biotopes I and II follows. Biotope III is terrestrial and therefore not included. Tables 31-35 list those organisms observed in the study area.

HARD AND SOFT CORALS

Biotope I includes the lagoon and its peripheral reef flat platforms divided into five concentric facies, beginning with the outermost area (Fig. 15). Coral cover on facies A was variably dense and diverse based on differing degrees of reef-flat exposure. In general, an increase in coral cover and diversity from the seaward side to the lagoon side was noted. Thirty-nine species representing 18 genera were observed.

Facies B consisted of the shallow lagoon terrace extending lagoonward to the 3 meter submarine contour. Width of this facies varied widely from 200-1000 meters. The boundary along the near shore shelf was demarcated by the seagrass Enhalus acoroides. Extensive regions of the terrace floor were covered by the staghorn coral, Acropora formosa. Thickets ranging in diameter from a few meters to many meters created a varied range of habitats. In general, coral growth was more dominant on the southern terrace. Toward the eastern end of the lagoon, the Acropora thickets became increasingly large with zones of mixed corals between patches. Coral diversity was highest here.

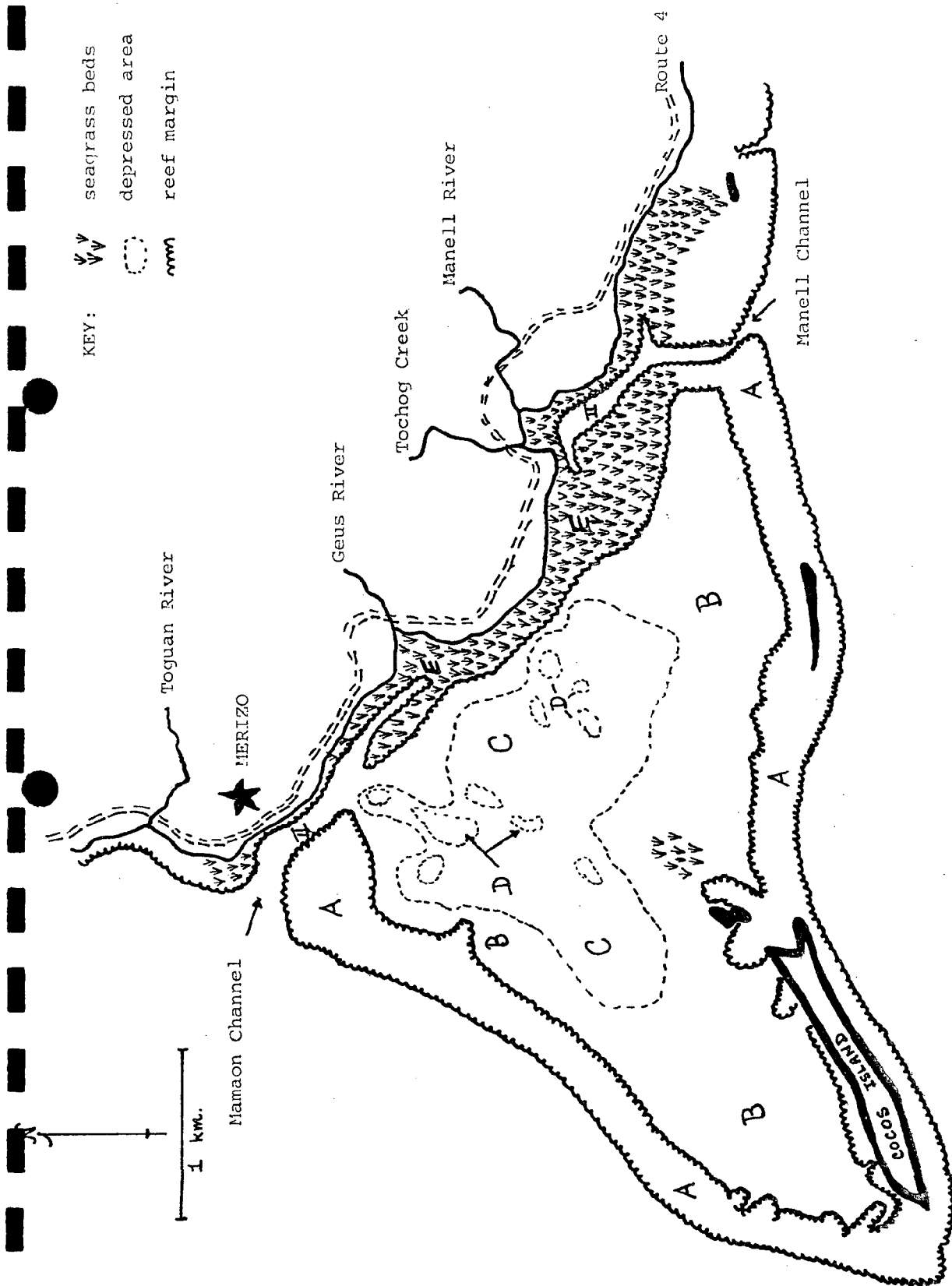


Figure 15. Map showing Biotope I and facies A through D of Cocos Lagoon and Barrier Reef.

The western portion of this area was devoid of corals for the most part. Seventy-nine species representing 27 genera were noted.

Facies C and D represent the central portion of the lagoon deeper than 3 meters and the patch reefs. The sand floor is interrupted by mounds, knolls and knobs. These relief features are zones rich in coral, algae, associated invertebrates and fish. These facies contained the richest and most diverse communities in biotope I. The under surface of overhanging mushroom shaped knolls are the habitats of various Leptoseris, Pavona, Plerogyra and Porites coral species, which are typically found in much deeper habitats. A total of 102 species representing 35 genera were observed.

Facies E consists of the narrow fringing reef bordering the landward side of the lagoon. The intertidal zone is dotted by mangrove patches (Mamaon Channel side) providing habitats for small gastropods and crabs. In general, this zone was rather barren. The most dominant community along the fringing reef-flat platform were the seagrasses.

Many beautiful soft corals (alcyonaceans and zoanthids) were noted in biotope I. Although they were seen in virtually all facies, they were particularly rich in facies C and D. Sinularia polydactyla was the most common. It was estimated that there was one soft coral for every 1.37 square meters. Facies E was also rich in soft corals.

Biotope II consists of the deep Mamaon and Manell barrier reef channels and their associated facies (Fig. 16). The shallow channel margins (Facies A) were highly variable with respect to coral density, diversity and physiographic character. In general, lagoonward sides of the channels were more highly developed with diversity highest at the channel mouths (particularly Mamaon). Several species of Porites dominated. Coral diversity for this facies was the highest in the lagoon with 104 species representing 34 genera.

The steep channel slopes (Facies B) and submarine cliffs (Facies C) ranged in depth from 3-30 meters. Characteristically turbid water and high sedimentation rates inhibited a rich coral growth though isolated patches were noted. The submarine cliff areas (near channel mouths) exhibited less sediment accumulation and therefore a more diverse community. Pavona and Acropora species were abundant in addition to Porites.

Facies D consisted of the cavernous parts of the channel including overhangs and ceilings. This area was considered rather special in that the low light intensities have allowed for the development of many deep water corals. Leptoseris sp., Stylocoeniella armata, Pavona minuta, Pachyseris speciosa, Porites (S.) hawaiiensis, Echinophyllia aspera, Mycedium, Plerogyra sinuosa and Euphyllia glabrescens were abundant. Bryozoans and larger foraminiferans were also common.

The channel floors (Facies E) are largely devoid of corals. A few small Porites colonies were noted. Near the channel mouths a

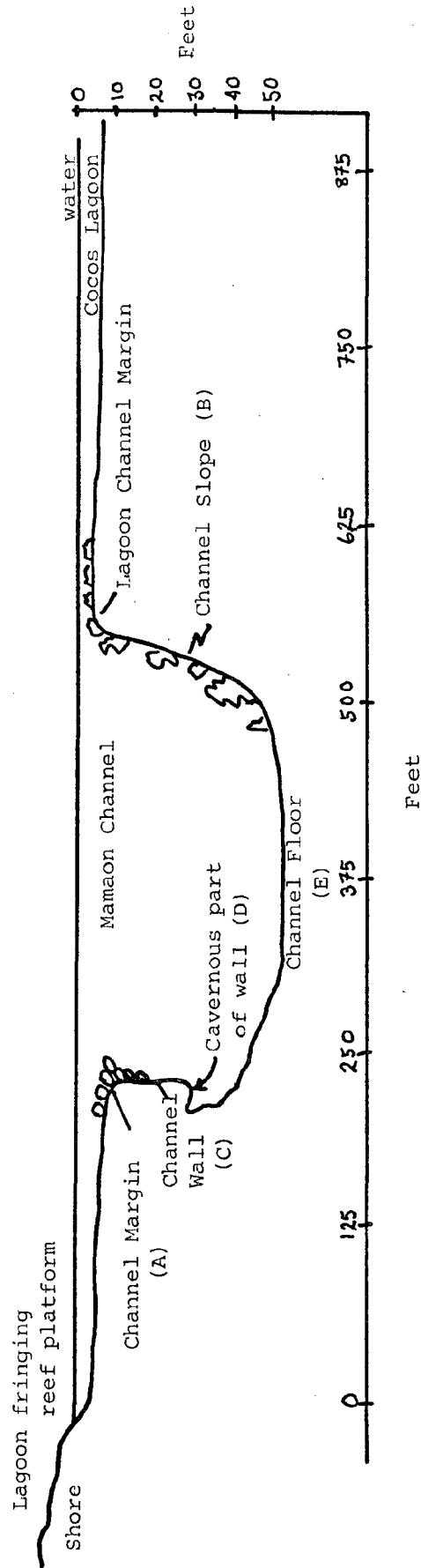


Figure 16. Generalized profile of Biotope II and Facies A through E of Mamaon Channel, Cocos Lagoon.

few gorgonians and small hydroids were seen.

The upper facies of Biotope II contained a diverse soft coral community. Twenty different species were observed compared to four in all other facies of both biotopes combined. Density, however, was considerably less than that found on the nearshore shelf described in Biotope I.

MARINE PLANTS

Marine flora for both biotopes was very diverse. Ninety-one species were observed. The highest diversity was found in biotopes IA (barrier reefs) and ID (patch reefs). The most depauperate areas were biotopes IC and IIE, lagoon and channel floors respectively.

Polysiphonia sp. and Dictyota bartayresii (windward side), and Caulerpa racemosa and Padina tenuis (leeward side), dominated Biotope IA. Polysiphonia sp. and Dictyota bartayresii also dominated Biotope IB. Biotope IC was dominated by Halimeda macroloba, Avrainvillea obscura, Halophila minor and Caulerpa sertularioides, all of which have specialized holdfast systems for sandy substrates. Biotope ID was dominated by Feldmannia indica, an important dietary item for juvenile siganids. Biotopes IE and IIA were vastly dominated by the seagrass Enhalus acoroides. Biotopes IIB-D were dominated by Halimeda incrassata and Tolypiocladia glomerulata. The crustose and coralline algae Porolithon onkodes and Peyssonellia sp. were virtually the only genera found in Biotope IIE.

MACROINVERTEBRATES

An inventory of the major macroinvertebrates is included in the species lists. Emphasis was placed on molluscs and echinoderms. No discussion of their relative abundance and distribution is given in the Randall report.

FISHES

The ichthyofauna found in Biotopes I and II was divided into a slightly different facies scheme (Fig. 17). These include the outside reef (I), channel walls (II), lagoon patch reefs (III), barrier reef flat (IV), seagrass beds (V), sand bottom (VI), estuarine and fresh-water (VII) and a miscellaneous category (M) for those fish observed by previous workers without regard to location. The following observations and conclusions were made regarding the fish population in the Cocos area (Jones and Chase, 1975).

Although the channel-wall (II) of Cocos Lagoon proved to be more diverse than the biotope outside the barrier (I), in terms of transect species, diversity, and biomass, it seems that the lagoon as a whole is not supporting an exceptionally rich ichthyofauna. . . Qualitative observations as well

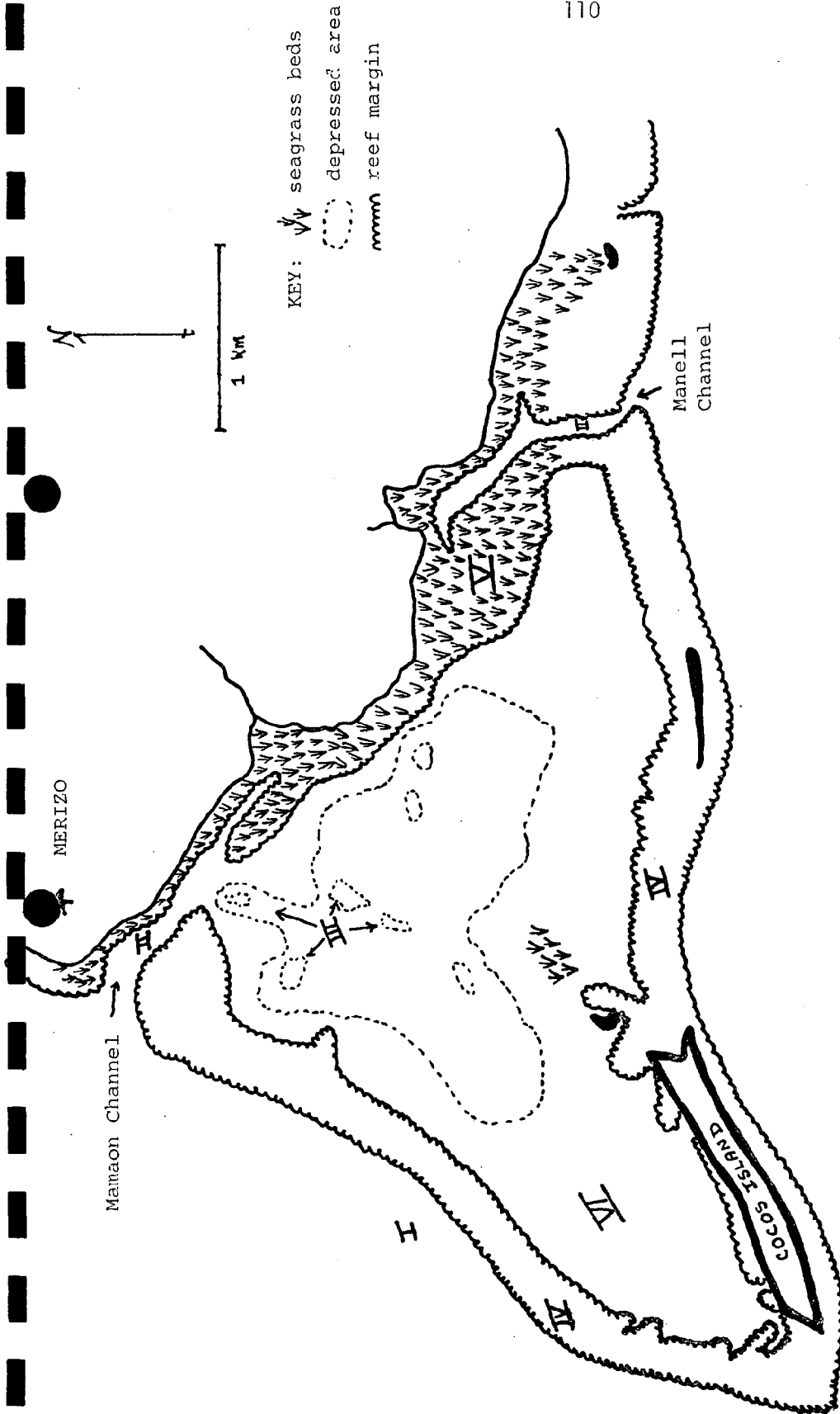


Figure 17. Ichthyofaunal Biotopes I through VI at Cocos Lagoon. (Adapted from Jones and Chase, 1975).

as many of our transect counts indicated that large numbers of juvenile reef fish species occurred in the lagoon. This was true both in areas with reef cover and in the seagrass beds. These observations lead us to believe that the lagoon's enclosed nature, coupled with the natural cover available, makes Cocos Lagoon an invaluable nursery for many of the species.

THREATENED AND ENDANGERED SPECIES

The federally registered endangered species Eretmochelys imbricata (hawksbill turtle) is often present in Cocos Lagoon. The sea cow Dugong dugong has been reported in the lagoon by Gowel, Hotaling and Tobias in 1974. Whether this organism is still present is doubtful. The coconut crab, Birgus latro, has been extensively harvested on Cocos Island and may be threatened. The coral Tubastrea aurea is rare on Guam but abundant throughout Micronesia.

WATER CLASSIFICATION

GEPA water classification ratings for this area are "A", recreational. Over twenty-five point source discharges are known along the Merizo coastline. Fortunately, most are small and the Manell and Mamaon channels are able to transport the discharges laterally into the Philippine Sea and Pacific Ocean, respectively, thus largely protecting the adjacent lagoon. While carrying capacity appears to be stable at the present time, the maximum supportable discharge load is not known and further development involving waste discharge must be carefully monitored.

CONCLUSIONS AND RECOMMENDATIONS

The beauty of the Cocos area, with its pristine lagoon and associated features as well as clear and protected waters make it an important preservation site for both scientific study and limited recreational use. No alternative site exists on Guam. The Cocos area is unique. Recreational development and tourism have increased tremendously, necessitating an immediate appraisal of potential environmental stresses. Randall et al. (1975) concluded that the delicate nature of the area is such that any physical disruption of the seagrass beds, coral reefs, etc., within the lagoon or immediately adjacent areas could have serious effects on the fish population in particular. For these reasons the following recommendations are suggested:

- 1) that the entire Cocos area be made into a marine sanctuary in which fishing, coral harvesting and shell collecting be outlawed except by special permit.
- 2) that the GEPA water quality classification be changed to "AA", conservation.

- 3) that an upper limit on the number and type of point source discharges into Mamaon and Manell Channels be established.
- 4) that strictly controlled recreational activities including SCUBA diving, snorkeling, and swimming be retained along with authorized glass bottom boat tours and the transport of picnickers and bathers to Cocos Island proper.
- 5) that an upper limit on the number of transport boats and persons utilizing the area at any given time be established.
- 6) that the entire Cocos area be made into a marine underwater park with trails and basic information on the geology, physiography and biota. This should be made available through pamphlets and signs in the area written in layman's language. The system could be modeled after Hanauma Bay (Oahu, Hawaii).
- 7) that the placement of artificial reefs and fish traps for scientific and maricultural purposes be allowed with the issuance of a special permit.
- 8) that strict litter laws be implemented, notably a "Thermos Law", curtailing the problem of waste beverage cans. This is already in effect on Cocos Island and should be added to the adjacent coastal areas included in the sanctuary.

Table 31. Checklist of marine plants observed at Cocos Lagoon.
(Adapted from Randall et al., 1975).

SPECIES	Biotope I					Biotope II				
	A	B	C	D	E	A	B	C	D	E
CYANOPHYTA (blue-green algae)										
<u>Calothrix crustacea</u>	x	x		x	x	x	x	x	x	
<u>Hormothamnion enteromorphoides</u>	x	x	x	x	x	x				
<u>Microcoleus lyngbyaceus</u>	x	x	x	x	x	x	x	x	x	x
<u>Schizothrix calcicola</u>	x	x		x	x	x	x	x	x	
<u>Schizothrix mexicana</u>	x	x		x	x	x				
<u>Rivularia atra</u>					x					
CHLOROPHYTA (green algae)										
<u>Acetabularia moebii</u>	x			x						
<u>Avrainvillea obscura</u>	x	x	x		x					
<u>Boergesenia forbesii</u>	x	x		x		x				
<u>Boodlea composita</u>	x	x		x	x	x	x	x	x	
<u>Caulerpa cupressoides</u>	x	x	x	x	x	x	x	x	x	
<u>Caulerpa filicoides</u>										x
<u>Caulerpa lentillifera</u>		x		x	x					x
<u>Caulerpa racemosa</u>	x	x	x	x	x	x	x	x	x	
<u>Caulerpa serrulata</u>	x	x		x	x	x				
<u>Caulerpa sertularioides</u>	x	x	x	x	x					x
<u>Caulerpa taxifolia</u>	x	x		x	x	x				
<u>Caulerpa verticillata</u>		x		x		x				
<u>Chlorodesmis fastigiata</u>	x			x	x	x	x	x	x	
<u>Cladophoropsis membranacea</u>	x				x					
<u>Codium edule</u>				x						
<u>Dictyosphaeria cavernosa</u>	x	x		x	x	x				
<u>Dictyosphaeria versluysii</u>	x	x		x	x	x	x	x	x	
<u>Enteromorpha compressa</u>					x					
<u>Halimeda copiosa</u>				x		x				
<u>Halimeda discoidea</u>	x	x		x	x	x	x	x	x	
<u>Halimeda gigas</u>						x	x	x	x	
<u>Halimeda incrassata</u>					x	x	x	x	x	
<u>Halimeda macroloba</u>	x	x	x	x	x					
<u>Halimeda opuntia</u>	x	x	x	x	x	x	x	x	x	x
<u>Neomeris annulata</u>	x			x	x	x				
<u>Neomeris vanbosseae</u>							x	x	x	
<u>Rhipilia orientalis</u>						x				
<u>Tydemannia expeditionis</u>	x			x	x	x				
<u>Udotea argentea</u>						x				x
<u>Valonia fastigiata</u>	x	x		x	x	x	x	x	x	
<u>Valonia ventricosa</u>	x	x		x	x	x				

Table 31. (continued)

SPECIES	Biotope I					Biotope II				
	A	B	C	D	E	A	B	C	D	E
PHAEOPHYTA (brown algae)										
<u>Chnoospora implexa</u>	x	x	x	x						
<u>Dictyota bartayresii</u>	x	x	x	x	x	x				x
<u>Dictyota cervicornis</u>	x	x	x	x	x					
<u>Dictyota divaricata</u>	x	x	x	x		x	x	x	x	
<u>Dictyota friabilis</u>	x	x		x			x	x	x	
<u>Dictyota patens</u>				x	x	x				
<u>Ectocarpus breviarticulatus</u>	x				x					
<u>Feldmannia indica</u>	x	x		x	x		x	x	x	
<u>Hydroclathrus clathratus</u>	x	x	x	x	x					
<u>Lobophora variegata</u>	x	x		x	x		x	x	x	
<u>Padina jonesii</u>			x			x	x	x	x	
<u>Padina tenuis</u>	x	x		x	x					
<u>Sargassum cristaefolium</u>	x									
<u>Sargassum polycystum</u>	x				x					
<u>Sphacelaria tribuloides</u>	x			x	x		x	x	x	
<u>Turbinaria ornata</u>	x	x		x	x	x	x	x	x	
RHODOPHYTA (red algae)										
<u>Acanthophora spicifera</u>	x	x	x	x		x	x	x	x	
<u>Actinotrichia fragilis</u>	x	x			x	x	x	x	x	
<u>Amphiroa foliacea</u>	x				x	x	x	x	x	
<u>Amphiroa fragilissima</u>	x	x		x	x	x	x	x	x	x
<u>Antithamnion</u> sp.										
<u>Asparagopsis taxiformis</u>						x				
<u>Botryocladia skottsbergii</u>				x						
<u>Centroceras clavulatum</u>				x						
<u>Ceramium</u> sp.				x						
<u>Champia parvula</u>				x						
<u>Desmia hornemanni</u>						x	x	x	x	
<u>Galaxaura fasciculata</u>	x	x		x	x	x				
<u>Galaxaura marginata</u>				x						x
<u>Galaxaura oblongata</u>		x		x		x	x	x	x	x
<u>Gelidiella acerosa</u>	x	x		x						
<u>Gelidiopsis intricata</u>	x	x		x	x					
<u>Gelidium divaricatum</u>	x	x		x	x	x	x	x	x	
<u>Gelidium pusillum</u>	x									
<u>Gracilaria arcuata</u>	x			x						
<u>Gracilaria crassa</u>	x			x	x					
<u>Griffithsia</u> sp.				x						
<u>Halymenia durvillaei</u>				x						
<u>Hypnea cervicornis</u>							x	x	x	
<u>Hypnea pannosa</u>	x	x		x	x	x	x	x	x	
<u>Hypnea valentiae</u>	x			x						

Table 31. (continued)

SPECIES	Biotope I					Biotope II				
	A	B	C	D	E	A	B	C	D	E
<u>Jania capillacea</u>	x			x		x	x	x	x	
<u>Laurencia</u> sp.					x					
<u>Lithophyllum</u> sp.	x	x		x	x	x	x	x	x	x
<u>Mastophora</u> sp.	x					x				
<u>Neogoniolithon</u> sp.							x	x	x	
<u>Peyssonelia</u> sp.				x		x	x	x	x	x
<u>Polysiphonia</u> sp.	x	x		x	x		x	x	x	
<u>Porolithon onkodes</u>	x									
<u>Porolithon</u> sp.	x	x			x	x				
<u>Rhodymenia</u> sp.	x	x		x	x	x				x
<u>Spyridia filamentosa</u>	x	x	x	x						
<u>Tolypiocladia glomerulata</u>	x			x		x	x	x	x	
<u>Trichogloea</u> sp.							x	x	x	

SPERMATOPHYTA (seagrass)

<u>Enhalus acoroides</u>					x
<u>Halodule uninervis</u>			x		
<u>Halophila minor</u>			x		

Table 32. Checklist of corals observed at Cocos Lagoon. (Adapted from Randall et al, 1975).

BIOTOPES	Biotope I					Biotope II				
	A	B	C	D	E	A	B	C	D	E
<u>Stylocoeniella armata</u>		x	x	x	x	x	x	x	x	
<u>Stylocoeniella guentheri</u>			x				x	x		x
<u>Psammocora contigua</u>	x	x			x	x				
<u>Psammocora nierstraszi</u>		x		x	x	x	x	x		
<u>Psammocora profundacella</u>							x			
<u>Psammocora stellata</u>	x	x			x	x				
<u>Psammocora verrilli</u>							x			
<u>Psammocora (S.) togianensis</u>		x		x		x	x			
<u>Psammocora (P.) haimeana</u>		x		x	x	x	x	x	x	
<u>Stylophora mordax</u>						x	x			
<u>Seriatopora hystrix</u>			x	x	x	x	x	x		
<u>Pocillopora brevicornis</u>		x		x	x	x				
<u>Pocillopora damicornis</u>	xx	x	x	x	x	x	x	x	x	x
<u>Pocillopora danae</u>		x		x						
<u>Pocillopora elegans</u>						x				
<u>Pocillopora eydouxi</u>						x	x			
<u>Pocillopora ligulata</u>		x				x				
<u>Pocillopora meandrina</u>		x		x		x				
<u>Pocillopora setchelli</u>						x				
<u>Pocillopora verrucosa</u>		x	x	x	x	x	x			
<u>Acropora abrotanoides</u>						x				
<u>Acropora acuminata</u>	x	x	x	x	x	x				
<u>Acropora arbuscula</u>	x	x	x	x	x					
<u>Acropora aspera</u>	x	x	x	x	x					
<u>Acropora brueggemanni</u>						x	x			
<u>Acropora convexa</u>						x	x			
<u>Acropora delicatula</u>				x			x	x		
<u>Acropora echinata</u>				x						
<u>Acropora formosa</u>	x	xx	xx	xx	x	x	x			
<u>Acropora hebes</u>	x	x								
<u>Acropora humulis</u>		x	x	x	x	x	x	x		
<u>Acropora hystrix</u>							x	x		
<u>Acropora kenti</u>			x				x	x		x
<u>Acropora murrayensis</u>						x	x			
<u>Acropora nana</u>						x				
<u>Acropora nasuta</u>		x	x	x		x	x			
<u>Acropora nobilis</u>		x								
<u>Acropora palifera</u>		x	x	x	x	x	x			
<u>Acropora palmerae</u>						x				
<u>Acropora rambleri</u>							x	x		x
<u>Acropora rayneri</u>							x	x		x
<u>Acropora smithi</u>						x				
<u>Acropora squarrosa</u>							x	x		
<u>Acropora surculosa</u>		x		x	x	x	x	x		
<u>Acropora syringodes</u>					x					

Table 32. (continued)

BIOTOPES	Biotope I					Biotope II				
	A	B	C	D	E	A	B	C	D	E
<u>Acropora studeri</u>						x	x			
<u>Acropora teres</u>	xx	xx	xx	xx	x	x	x			
<u>Acropora tubicinaria</u>		x		x						
<u>Acropora virgata</u>		x	x	x						
<u>Acropora wardii</u>				x						
<u>Acropora sp. 1</u>						x				
<u>Astreopora gracilis</u>				x		x				
<u>Astreopora listeri</u>				x		x				
<u>Astreopora myriophthalma</u>		x		x		x	x	x		
<u>Montipora composita</u>									x	x
<u>Montipora conicula</u>							x			
<u>Montipora ehrenbergii</u>				x		x	x			
<u>Montipora elschneri</u>				x	x	x				
<u>Montipora floweri</u>							x			
<u>Montipora foveolata</u>		x	x	x	x	x	x	x	x	x
<u>Montipora granulosa</u>			x				x			
<u>Montipora hoffmeisteri</u>		x		x		x	x			
<u>Montipora lobulata</u>	x	x	x	xx	x	x	x			
<u>Montipora monasteriata</u>						x				
<u>Montipora patula</u>						x				
<u>Montipora subtilis</u>		x	x	x			x			
<u>Montipora tuberculosa</u>		x		x		x				
<u>Montipora verilli</u>	x	x	x	x	x	xx	x	x		
<u>Montipora verrucosa</u>		x	x	x		x	x	x	x	x
<u>Pavona clavus</u>						x	x			
<u>Pavona decussata</u>	x	x			xx	x				
<u>Pavona divaricata</u>	x				x					
<u>Pavona frondifera</u>	x				x					
<u>Pavona minuta</u>									x	x
<u>Pavona varians</u>	x	x	x	x	x	x	x	x	x	
<u>Pavona gardineri</u>								x		x
<u>Pavona (P.) pollicata</u>								x		
<u>Pavona (P.) planulata</u>				x		x	x	x		
<u>Pavona (P.) obtusata</u>	x	x	x	x		x	x	x		
<u>Pavona (P.) sp. 1</u>				x	x	x	x			
<u>Leptoseris hawaiiensis</u>			x	x					x	x
<u>Leptoseris incrustans</u>			x	x					x	x
<u>Leptoseris mycetoseroides</u>									x	
<u>Pachyseris speciosa</u>								x	x	x
<u>Anomastrea sp. 1</u>		x	x	x		x	x	x	x	
<u>Coscinaraea columna</u>						x				
<u>Cycloseris sp. 1</u>										x
<u>Fungia fungites</u>		x		x			x			
<u>Fungia scutaria</u>		x	x	x			x			
<u>Goniopora columna</u>							x			
<u>Goniopora arbuscula</u>	x	x	x	x		x	x			
<u>Stylaraea punctata</u>	x	x	x	xx	x	x	x	x		x

Table 32. (continued)

BIOTOPES	Biotope I					Biotope II				
	A	B	C	D	E	A	B	C	D	E
<u>Porites andrewsi</u>	x	xx	x							
<u>Porites annae</u>	x	x		x	x	x				
<u>Porites australiensis</u>		x		x		x				
<u>Porites cocosensis</u>	x	xx	xx	xx	x	x	x	x		x
<u>Porites compressa</u>	x	x	x	x		x				
<u>Porites duerdeni</u>		x								
<u>Porites lichen</u>		x		x		x	x			
<u>Porites lobata</u>	x	x	x	x		x	x	x		x
<u>Porites lutea</u> ⁺	xx	xx	x	xx	x	xx	x	x		x
<u>Porites murrayensis</u>		x		x		x	x			
<u>Porites matthaii</u>	x	xx	x	xx	x	xx	x	x		x
<u>Porites</u> sp. 1						x				
<u>Porites</u> sp. 2				x		x	x			
<u>Porites</u> (S.) <u>convexa</u>		x	x	xx	x	x	xx	x		x
<u>Porites</u> (S.) <u>hawaiiensis</u>		x	x	x		x	x	x	xx	x
<u>Porites</u> (S.) <u>horizontalata</u>			x	x			x	x	x	x
<u>Porites</u> (S.) <u>iwayamaensis</u>	x	x	x	xx	x	x	xx	xx	x	x
<u>Porites</u> (S.) sp. 1				x		x				
<u>Alveopora japonica</u>		x								
<u>Alveopora verrilliana</u>						x	x			
<u>Favia favius</u>		x								
<u>Favia pallida</u>		x	x	x		x	x	x		x
<u>Favia speciosa</u>		x		x		x	x	x		
<u>Favia stelligera</u>		x		x			x			
<u>Favia rotumana</u>				x			x			
<u>Favites abdita</u>						x				
<u>Favites complanata</u>		x	x	x		x	x	x		
<u>Favites favosa</u>				x			x			
<u>Favites flexuosa</u>				x			x			
<u>Favites virens</u>				x		x				
<u>Oulophyllia crispa</u>				x			x			
<u>Plesiastrea versipora</u>				x		x	x			
<u>Plesiastrea</u> sp. 1				x		x	x			
<u>Goniastrea parvistella</u>	x	x	x	x	x	x	x	x		
<u>Goniastrea pectinata</u>		x		x		x	x	x		
<u>Goniastrea retiformis</u>	x	x		x		x	x			
<u>Platygyra rustica</u>	x	x		x		x	x			
<u>Platygyra lamellina</u>				x			x			
<u>Platygyra sinensis</u>		x		x		x	x	x		
<u>Leptoria phrygia</u>		x		x		x	x	x		
<u>Hydnophora microconos</u>				x		x	x	x		
<u>Leptastrea bottae</u>	x	x			x	x				
<u>Leptastrea purpurea</u>	x	xx	x	xx	x	xx	xx	x	x	x
<u>Leptastrea transversa</u>				x			x			
<u>Cyphastrea chalcidicum</u>				x						

Table 32. (continued)

BIOTOPES	Biotope I					Biotope II				
	A	B	C	D	E	A	B	C	D	E
<u>Cyphastrea serailia</u>	x	x		x		x	x	x		x
<u>Cyphastrea</u> sp. 1				x						
<u>Echinopora lamellosa</u>				x		x		x		
<u>Diploastrea heliopora</u>							x	x		
<u>Galaxea fascicularis</u>	x	x	x	x	x	x	x	x		
<u>Galaxea hexagonalis</u>							x			
<u>Acrhelia horrescens</u>		x	x	x	x	x	x	x		
<u>Merulina ampliata</u>							x	x	x	
<u>Lobophyllia corymbosa</u>	x	x	x	x		x	x	x		
<u>Lobophyllia costata</u>				x		x				
<u>Lobophyllia hemprichii</u>				x			x			
<u>Acanthastrea echinata</u>				x		xx	x			
<u>Echinophyllia aspera</u>			x	x		x	x	x	x	x
<u>Mycedium</u> sp. 1				x						x
<u>Paracyathus</u> sp. 1				x						x
<u>Plerogyra sinuosa</u>		x	x	x		x	x	x	x	x
<u>Euphyllia glabrescens</u>	x	x	x	x		x	x	x	x	x
<u>Heliopora coerulea</u>	x	x	x	x	x	x	x	x		
<u>Millepora dichotoma</u>	x	x		x		x	x			
<u>Millepora exaesa</u>		x	x	x	x	xx	x	x	x	x
<u>Millepora platyphylla</u>	x	x		x		x	x	x		
<u>Distichopora violacea</u>						x	x	x	x	x

Total Species 159

Total Genera 44

Table 33. Checklist of soft corals observed at Cocos Lagoon.
(Adapted from Randall et al., 1975).

BIOTOPES	Biotope I						Biotope III			
	A _W	A _L	B	C	D	E	A	B	C	D
ASTEROSPICULARIIDAE										
<u>Asterospicularia randalli</u>	x		x		x					
ALCYONIIDAE										
<u>Alcyonium</u> sp. 1		x			x		x			
<u>Cladiella</u> sp. 1							x			
<u>Cladiella</u> sp. 2							x			
<u>Lobophytum</u> sp. 1							x			
<u>Lobophytum</u> sp. 2							x			
<u>Lobophytum</u> sp. 3							x			
<u>Sarcophyton</u> sp. 1				x	x	x				
<u>Sarcophyton</u> sp. 2		x					x	x		
<u>Sinularia polydactyla</u>		x	x	x	x	x	x			
<u>Sinularia conferta</u> var. <u>gracilis</u>	x		x			x	x			
<u>Sinularia</u> sp. 1					x					
<u>Sinularia</u> sp. 2							x			
<u>Sinularia</u> sp. 3							x			
<u>Sinularia</u> sp. 4							x			
<u>Sinularia</u> sp. 5								x		
<u>Sinularia</u> sp. 6								x		
<u>Sinularia</u> sp. 7								x		
<u>Sinularia</u> sp. 8								x		
<u>Sinularia</u> sp. 9		x								
<u>Sympodium coeruleum</u>							x			
NEPHTHYIDAE										
Species 1							x			
Species 2							x			
XENIIDAE										
<u>Xenia</u> sp.						x				
ZOANTHIDAE										
<u>Palythoa</u> sp.							x	x	x	x
<u>Zoanthus</u> sp.						x				

Table 34. Checklist of common macroinvertebrates, other than corals, observed in Cocos Lagoon. (Adapted from Randall et al., 1975).

SPECIES	Biotope I					Biotope II				
	A	B	C	D	E	A	B	C	D	E
PROTOZOA										
SARCODINA										
<u>Marginopora vertebralis</u>					x					
CNIDARIA										
SCYPHOZOA										
<u>Cassiopea andromeda</u>					x					
<u>Stephanoscyphus racemosus</u>							x			
HYDROZOA										
<u>Porpita</u> sp.					x					
ANNELIDA										
POLYCHAETA										
<u>Spirorbis</u> sp.					x					
MOLLUSCA										
GASTROPODA and BIVALVIA (*)										
<u>Acmaea</u> sp.					x					
<u>Arca ventricosa</u>					x					
<u>Astridium petrosum</u>									x	
<u>Barbatia</u> sp.		x	x							
<u>Bursa</u> sp.		x								
<u>Cantharus fumosus</u>		x								
<u>Cantharus undosus</u>		x								
<u>Cantharus</u> sp.		x								
<u>Cerithium columna</u>		x								
<u>Cerithium nesioticum</u>		x								
<u>Cerithium nodulosum</u>		x	x							
<u>Cerithium ravidum</u>			x							
<u>Cerithium</u> sp.									x	
<u>Chicoreus brunneus</u>			x							
<u>Chione</u> sp.			x							
<u>Chlarys</u> sp.					x					
* <u>Codakia divergens</u>									x	
<u>Contumax nodulosus</u>			x							
<u>Conus arenatus</u>		x								
<u>Conus distans</u>		x								
<u>Conus flavidus</u>			x							
<u>Conus ebraeus</u>		x								
<u>Conus imperialis</u>					x					
<u>Conus litteratus</u>					x					

Table 34. (continued)

[illegible]

Table 34. (continued)

[illegible]

Table 34. (continued)

[illegible]

Table 35. Checklist of fishes observed at Cocos Lagoon. Category M (miscellaneous) lists those fish reported by various workers for which the exact locations were not specified. (Adapted from Randall et al, 1975).

SPECIES	FISH BIOTOPES							Misc.
	I	II	III	IV	V	VI		

ACANTHURIDAE								
<u>Acanthurus glaucopareius</u>	x	x	x					
<u>A. lineatus</u>	x	x						
<u>A. mata</u>								x
<u>A. nigrofuscus</u>	x	x	x	x				
<u>A. olivaceus</u>								x
<u>A. pyroferus</u>	x	x						
<u>A. thompsoni</u>	x							
<u>A. triostegus</u>		x	x	x				
<u>A. xanthopterus</u>	x	x	x			x		
<u>Ctenochaetus binotatus</u>	x	x						
<u>C. striatus</u>	x	x	x	x				
<u>Naso brevirostris</u>	x							
<u>N. hexacanthus</u>	x							
<u>N. lituratus</u>	x	x	x	x				
<u>N. unicornis</u>	x	x	x	x				
<u>Zebrasoma flavescens</u>	x	x	x					
<u>Z. scopas</u>		x	x					
<u>Z. veliferum</u>	x	x	x					

APOGONIDAE								
<u>Apogon exostigma</u>		x						
<u>A. leptacanthus</u>								x
<u>A. mydrus</u>								x
<u>A. novemfasciatus</u>					x			
<u>A. robustus</u>								x
<u>A. trimaculatus</u>								x
<u>A. sp.</u>		x						
<u>Cheilodipterus macrodon</u>		x	x					
<u>C. quinquelineata</u>		x	x			x		

ATHERINIDAE								
<u>Pranesus insularum</u>								x

AULOSTOMIDAE								
<u>Aulostomus chinensis</u>	x	x	x		x			

Table 35. (continued)

SPECIES	FISH BIOTOPES						
	I	II	III	IV	V	VI	Misc.
BALISTIDAE							
<u>Balistapus undulatus</u>	x	x					
<u>Balistoides niger</u>	x						
<u>Melichthys niger</u>	x						
<u>M. vidua</u>	x						
<u>Pseudobalistes flavomarginatus</u>			x				
<u>Rhinecanthus aculeatus</u>				x			
<u>R. rectangulus</u>				x			
<u>Sufflamen bursa</u>	x						
<u>S. chrysoptera</u>	x	x					
BLENNIIDAE							
<u>Aspidontus taeniatus</u>	x	x	x	x			
<u>Cirripectes sebae</u>	x						
<u>C. variolosus</u>	x	x		x			
<u>Ecsenius bicolor</u>	x						
<u>E. opsifrontalis</u>	x						
<u>Exallias brevis</u>	x						
<u>Istiblennius coronatus</u>	x			x			
<u>Meiacanthus atrodorsalis</u>	x	x	x				
<u>Petroscirtes mitratus</u>					x	x	
<u>Plagiotremus tapeinosoma</u>	x	x		x			
<u>P. sp.</u>	x						
<u>Salarias fasciatus</u>	x			x			
BOTHIDAE							
<u>Bothus mancus</u>		x					
CANTHIGASTERIDAE							
<u>Canthigaster amboinensis</u>	x						
<u>C. coronatus</u>	x	x	x				
<u>C. janthinopterus</u>	x	x					
<u>C. solandri</u>	x	x	x	x			
CARACANTHIDAE							
<u>Caracanthus maculatus</u>	x						
CARANGIDAE							
<u>Carangoides malabaricus</u>	x						
<u>Caranx melampygus</u>	x		x			x	
<u>Gnathanodon speciosus</u>							x

Table 35. (continued)

SPECIES	FISH BIOTOPES						
	I	II	III	IV	V	VI	Misc.
CARAPIDAE							
<u>Carapus homei</u>							x
CHAETODONTIDAE							
<u>Centropyge bispinosus</u>	x						
<u>C. flavissimus</u>	x	x	x	x			
<u>C. heraldi</u>	x						
<u>Chaeotodon auriga</u>	x	x	x	x			
<u>C. bennetti</u>	x	x	x				
<u>C. citrinellus</u>	x	x	x	x			
<u>C. ephippium</u>	x	x	x	x			
<u>C. falcula (=C. ulietensis)</u>	x	x	x				
<u>C. kleini</u>		x					
<u>C. lunula</u>	x	x	x	x			
<u>C. melannotus</u>		x	x				
<u>C. mertensii</u>	x	x	x				
<u>C. ornatissimus</u>	x	x					
<u>C. punctato-fasciatus</u>	x	x	x				
<u>C. quadrimaculatus</u>	x						
<u>C. reticulatus</u>	x	x	x				
<u>C. strigangulus (=C. trifasialis)</u>	x		x				
<u>C. trifasciatus</u>	x	x	x	x			
<u>C. unimaculatus</u>	x	x					
<u>Forcipiger flavissimus</u>	x	x					
<u>Heniochus permutatus</u>	x	x	x				
<u>H. varius</u>							x
<u>H. monoceros</u>	x	x	x	x			
<u>Holacanthus trimaculatus</u>	x						
<u>Pomacanthus imperator</u>		x		x			
<u>Pygoplites diacanthus</u>		x					
CIRRHITIDAE							
<u>Cirrhitus pinnulatus</u>	x						
<u>Neocirrhitus armatus</u>	x						
<u>Paracirrhitus arcatus</u>	x		x				
<u>P. forsteri</u>	x	x					
<u>P. hemistictus</u>	x						
DASYATIDAE							
<u>Dasyatis kuhli</u>							x
DIODONTIDAE							
<u>Diodon hystrix</u>							x

Table 35. (continued)

SPECIES	FISH BIOTOPES						
	I	II	III	IV	V	VI	Misc.
ENGRAULIDAE							
<u>Thrissina baelama</u>							x
FISTULARIDAE							
<u>Fistularia petimba</u>				x			
GOBIIDAE							
<u>Acentrogobius belissimus</u>		x	x				
<u>A. triangularis</u>							x
<u>Amblygobius albimaculatus</u>		x	x	x	x	x	
<u>A. decussatus</u>							x
<u>A. sp.</u>						x	
<u>Asterropteryx semipunctatus</u>				x	x	x	
<u>Bathygobius fuscus</u>							x
<u>Eleotriodes strigata</u>	x			x			
<u>Eviota prasites</u>							x
<u>Gnatholepis deltoides</u>		x		x	x		
<u>Gobius ornatus</u>					x	x	
<u>Nemateleotris magnificus</u>		x					
<u>Obtortioophagus kousmani</u>						x	
<u>Oxyurichthys guibei</u>						x	
<u>Periopthalmus koelreuteri</u>							x
<u>Pogonoculius zebra</u>	x						
<u>Ptereleotris tricolor</u>	x						
<u>Rhinogobius decoratus</u>							x
<u>Trimma caesiura</u>							x
HEMIRAMPHIDAE							
<u>Hyporhamphus laticeps</u>							x
HOLOCENTRIDAE							
<u>Adioryx caudimacula</u>	x						
<u>A. microstomus</u>	x			x			
<u>A. spinifer</u>	x	x		x			
<u>A. tiere</u>	x						
<u>A. lacteoguttatus</u>							x
<u>A. sp.</u>							x
<u>Flammeo sammara</u>		x	x	x			
<u>Myripristis amaenus</u>		x	x				
<u>M. kuntze</u>		x					
<u>M. microphthalmus</u>							x
<u>M. murdjan</u>							

Table 35. (continued)

SPECIES	FISH BIOTOPES						
	I	II	III	IV	V	VI	Misc.
KUHLIIDAE							
<u>Kuhlia taeniura</u>							x
KYPHOSIDAE							
<u>Kyphosus cinerascens</u>							x
LABRIDAE							
<u>Anampses caeruleopunctatus</u>	x						
<u>Cheilinus celebicus</u>							x
<u>C. chlorourus</u>		x	x	x	x		
<u>C. fasciatus</u>	x	x	x	x	x		
<u>C. rhodochrous</u>	x	x	x				
<u>C. trilobatus</u>	x	x	x	x			
<u>C. undulatus</u>	x	x	x	x			
<u>Cheilio inermis</u>						x	x
<u>Cirrhilabrus temmincki</u>	x						
<u>Coris aygula</u>							x
<u>C. gaimard</u>	x			x			
<u>Epibulus insidiator</u>	x	x	x	x			
<u>Gomphosus varius</u>	x	x	x	x			
<u>Halichoeres biocellatus</u>	x						
<u>H. hortulanus (=H. centiquadrus)</u>	x	x		x			
<u>H. margaritaceus</u>	x	x		x	x		
<u>H. marginatus</u>	x	x		x			
<u>H. trimaculatus</u>		x	x	x	x		
<u>Hemigymnus fasciatus</u>	x	x					
<u>H. melapterus</u>	x	x	x	x	x		
<u>Hemipteronotus sp.</u>	x				x	x	
<u>Labrichthys unilineata</u>		x	x				
<u>Labroides bicolor</u>	x	x					
<u>L. dimidiatus</u>	x	x	x	x			
<u>Macropharyngodon meleagris</u>		x					
<u>M. pardalis</u>	x	x		x			
<u>Pseudocheilinus hexataenia</u>	x	x	x				
<u>Pteragogus guttatus</u>		x					
<u>Stethojulis (axillaris)</u>							
<u>bandanensis</u>	x	x	x	x	x	x	
<u>S. strigiventer</u>		x	x		x		
<u>Thalassoma amblycephalus</u>	x	x					
<u>T. hardwickei</u>	x	x	x	x			
<u>T. lutescens</u>	x	x	x	x			
<u>T. purpureum</u>	x			x			
<u>T. quinquevittata</u>	x			x			
<u>Xyrichtys taeniourus</u>	x			x			

Table 35. (continued)

SPECIES	FISH BIOTOPES						
	I	II	III	IV	V	VI	Misc.
LUTJANIDAE							
<u>Aphareus furcatus</u>	x	x	x				
<u>Aprion virescens</u>	x						
<u>Caesio caerulaureus</u>							x
<u>Gnathodentex aureolineatus</u>		x					
<u>Lethrinus reticulatus</u>							x
<u>L. rhodopterus</u>	x	x	x	x	x		
<u>L. sp.</u>			x		x		
<u>Lutjanus argentimaculatus</u>	x	x					
<u>L. (vaigiensis) fulvus</u>	x	x	x	x			
<u>L. kasmira</u>							x
<u>L. monostigmus</u>	x						
<u>Macolor niger</u>							x
<u>Scolopsis cancellatus</u>			x	x			
MALACANTHIDAE							
<u>Malacanthus scripta</u>							x
MONACANTHIDAE							
<u>Alutera scripta</u>							x
<u>Amanses carolae</u>	x						
<u>A. sandwichensis</u>	x	x	x				
<u>Oxymonacanthus longirostris</u>	x	x	x	x			
<u>Paraluteres prionurus</u>		x					
<u>Pervagor melanocephalus</u>							x
MONODACTYLIDAE							
<u>Monodactylus argenteus</u>		x					
MUGILIDAE							
<u>Chelon vaigiensis</u>							x
<u>Crenimugil crenilabis</u>							x
<u>Mugil cephalus</u>							x
MUGILOIDIDAE							
<u>Parapercis cephalopunctatus</u>	x	x					
<u>P. clathrata</u>	x	x		x			

Table 35. (continued)

SPECIES	FISH BIOTOPES						
	I	II	III	IV	V	VI	Misc.
MULLIDAE							
<u>Mulloidichthys auriflamma</u>			X				
<u>M. samoensis</u>		X	X	X	X	X	
<u>Parupeneus barberinus</u>	X	X	X	X	X		
<u>P. bifasciatus</u>	X			X			
<u>P. cyclostomus</u>	X	X	X	X			
<u>P. multifasciatus</u>	X	X	X	X	X		
<u>P. pleurostigma</u>		X		X	X		
<u>P. prophyreus</u>		X	X		X		
<u>Upeneus vittatus</u>							X
MURAENIDAE							
<u>Echidna nebulosa</u>		X		X			
<u>E. zebra</u>							X
<u>Gymnothorax gracilicaudus</u>							X
<u>G. javanicus</u>		X					
<u>G. pictus</u>							X
<u>G. undulatus</u>	X						
<u>Uropterygius concolor</u>							X
MYLIOBATIDAE							
<u>Aetobatus narinari</u>							X
OPHICHTHIDAE							
<u>Leiuranus semicinctus</u>							X
OSTRACIONTIDAE							
<u>Lactoria cornutus</u>							X
<u>Ostracion cubicus</u>		X	X				
<u>O. meleagris camurum</u>	X	X	X				
PEMPHERIDAE							
<u>Pempheris oualensis</u>		X					
POMACENTRIDAE							
<u>Abudefduf amabilis</u> (=Glyphidodontops leucopomus)	X	X		X			
<u>A. curacao</u> (=Amblyglyphidodon curacao)		X	X				
<u>A. dickii</u> (=Plectroglyphidodon dickii)	X	X					
<u>A. glaucus</u> (=G. glaucus)				X			
<u>A. imparipennis</u> (=P. imparipennis)	X						

Table 35. (continued)

SPECIES	FISH BIOTOPES						
	I	II	III	IV	V	VI	Misc.
<u>A. johnstonianus</u> (=Plectroglyhidodon johnstonianus)	x						
<u>A. lacrymatus</u> (=P. <u>lachrymatus</u>)	x	x	x	x			
<u>A. leucopomus</u> (=G. <u>leucopomus</u>)	x	x		x			
<u>A. leucozona</u> (=P. <u>leucozona</u>)				x			
<u>A. saxatilis</u>	x						
<u>A. septemfasciatus</u>	x			x			
<u>A. sexfasciatus</u> (=A. <u>coelestinus</u>)			x				
<u>Amphiprion bicinctus</u>							x
<u>A. chrysopterus</u>	x			x			
<u>A. melanopus</u>		x	x	x			
<u>A. perideraion</u>	x						
<u>Chromis atripectoralis</u>		x	x	x			
<u>C. caerulea</u>		x	x	x			
<u>C. (dimidiatus) hanui</u> (=C. <u>margaritifer</u>)	x	x					
<u>C. leucurus</u> (=C. <u>margaritifer</u>)	x						
<u>C. vanderbilti</u>	x						
<u>C. xanthochir</u>	x						
<u>C. sp.</u>	x	x					
<u>Dascyllus aruanus</u>		x	x	x			
<u>D. reticulatus</u>	x	x					
<u>D. trimaculatus</u>	x	x		x			
<u>Pomacentrus albobfasciatus</u> (=Eupomacentrus <u>albifasciatus</u>)				x			
<u>P. amboinensis</u>		x					
<u>P. jenkinsi</u> (=E. <u>fasciatus</u>)	x	x		x			
<u>P. lividus</u> (=E. <u>lividus</u>)		x	x	x			
<u>P. nigricans</u> (=E. <u>nigricans</u>)		x	x	x			
<u>P. pavo</u>		x	x				
<u>P. traceyi</u>	x	x	x				
<u>P. vaiuli</u>	x	x	x	x			
<u>P. sp.</u>	x						

PSEUDOCROMIDAE

Plesiops corallicola

x

SCARIDAE

Calatomus spinidens

x x

Chlorurus bicolor

x x

C. gibbus

x

Leptoscarus vaigiensis

x

Scarus dubius

x x x x

S. lepidus

x x x x

S. sordidus

x x x x x

S. venosus

x x x x

Table 35. (continued)

SPECIES	FISH BIOTOPES						
	I	II	III	IV	V	VI	Misc.
SCORPAENIDAE							
<u>Pterois antennata</u>							x
<u>P. volitans</u>	x	x					
<u>Scorpaenopsis gibbosa</u>							x
SERRANIDAE							
<u>Cephalopholis argus</u>							x
<u>C. urodelus</u>	x						
<u>Epinephelus emoryi</u>	x						
<u>E. merra</u>		x	x	x			
<u>Grammistes sexlineatus</u>	x						
SIGANIDAE							
<u>Siganus argenteus</u>						x	
<u>S. punctatus</u>			x				
<u>S. spinus</u>				x	x		
SPARIDAE							
<u>Monotaxis grandoculis</u>	x	x	x	x			
SPHYRAENIDAE							
<u>Sphyraena</u> sp.						x	
SYNGNATHIDAE							
<u>Corythoichthys intestinalis</u>							
<u>waitiei</u>		x	x		x		
<u>C. sp.</u>				x			
SYNODONTIDAE							
<u>Saurida gracilis</u>		x				x	
<u>Synodus variegatus</u>		x	x	x		x	
TETRAODONTIDAE							
<u>Arothron alboreticulatus</u>	x	x					
<u>A. immaculatus</u>						x	
ZANCLIDAE							
<u>Zanclus cornutus</u>	x	x	x	x			

AREA X:
AJAYAN BAY

Ajayan Bay is located on the southeast coast of Guam, along Route 4 just north of Manell Channel (Fig. 18). The area was chosen because of its well developed fringing reef channel and extensive seagrass beds.

No previous survey has been done for Ajayan Bay with respect to the marine biotic community. Moore *et al.* (1977) studied the Ajayan River basin wetland area. Most of their report deals with terrestrial communities and is not included here. Randall and Holloman (1974) provide an excellent physiographic description of the area. The following summary is taken in part from their report.

The fringing reef platform bordering most of the southeast shoreline is completely cut by the Ajayan River, forming a small estuary embayment with moderate alluvial silt deposition at the river mouth. Portions of the reef flat are markedly depressed as a result of local faulting. A small islet (Agrigan Island) is located on the southwest reef flat. The channel is characterized by progressively steeper fringing reef walls seaward to approximately 18 meters in depth. The floor of the channel grades from a silt-mud zone to sand approximately midway out. Water visibility improved seaward. The reef flats are wide and largely covered by seagrass beds on the inside, representing some of the most extensive communities of their type on Guam.

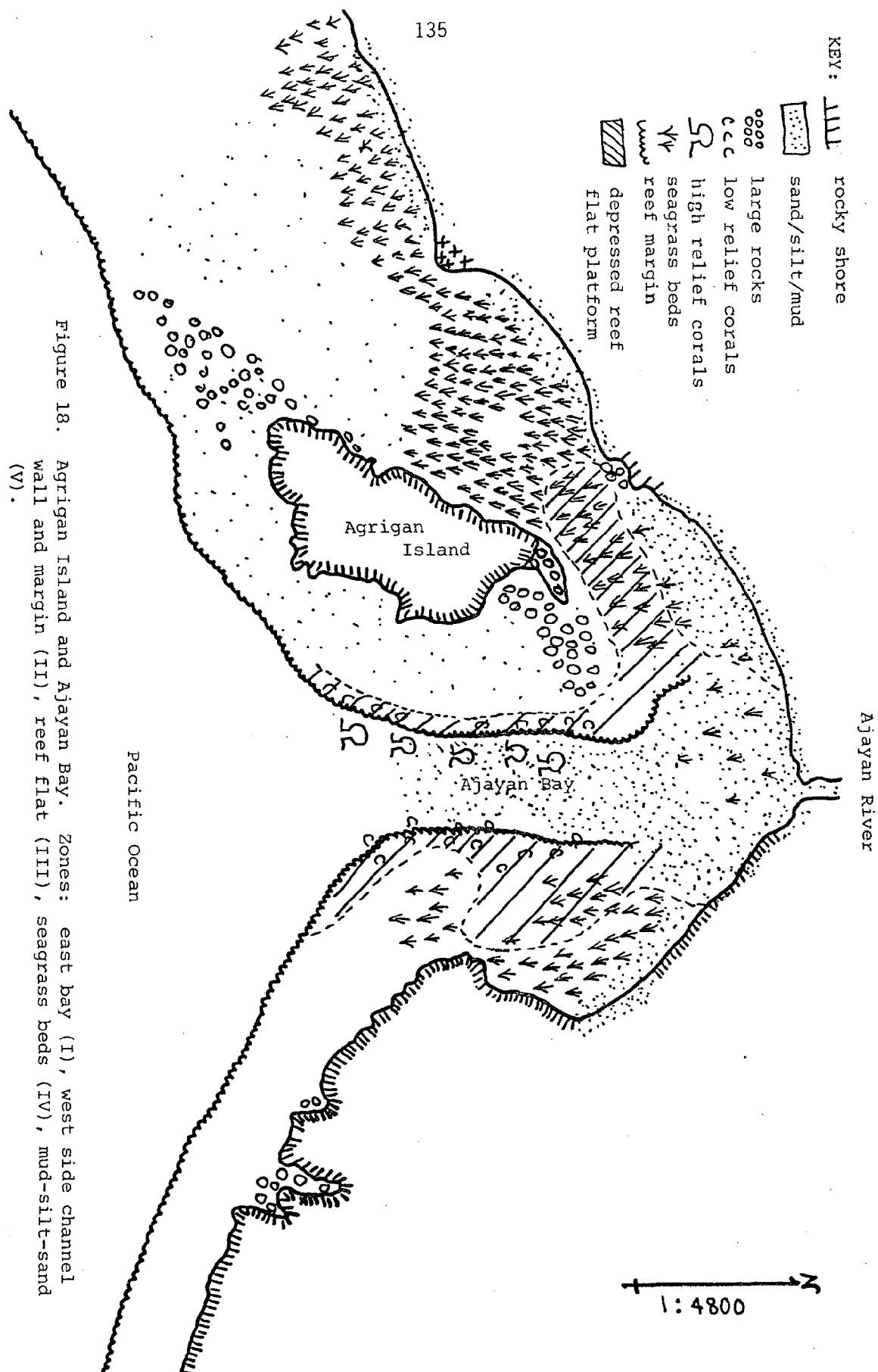
The Guam Environmental Protection Agency water rating for Ajayan Bay is "A" - recreational. No point source discharges are known in the immediate area (Shidel, 1977).

Two visits were made to Ajayan Bay. For purposes of this report the area was divided into five zones: (1) east bay, (2) west side channel wall and margin, (3) reef-flat, (4) seagrass beds and (5) mud-silt zone. Tables 36-39 list those organisms observed during the study.

The east and west side channel walls (Zones 1 and 2) were considerably different in both physiography and associated biota. The east bay sloped gradually to the channel floor while the west channel wall dropped almost vertically. The inner bay had a considerably higher silt content resulting in a less rich community development.

A wide variety of algae was found equally distributed along the length of both channel walls, with the marked exception of Asparagopsis taxiformis which was limited to the east side only. Abundance and diversity also tended to increase seaward as the water became clearer.

Coral development was considerably more diverse on the west side and again became richer seaward.



A diverse and abundant fish community exists which appeared to be fairly homogeneous. Of particular concern were the presence of numerous stone fish (Synanceia verrucosa). Eight individuals were seen along both sides of the channel around the upper reef margin and flat.

The reef flat (Zone 3) on the west side was largely depauperate due to frequent exposure during low tides. Patchy areas of Schizothrix, Boergesenia, Dictyosphaeria, Dictyota, Lobophora, Turbinaria, Gelidium and Jania species comprised the major algal genera observed.

A few scattered corals were observed in water filled crevices and holes. The macroinvertebrate community was rich but not particularly diverse. Gastropods, holothurians and crabs were the dominant forms.

The seagrass beds (Zone 4) at Ajayan are among the most extensive and beautiful on Guam. At the time of the study, the tide was low and about 15 centimeters of water covered the Enhalus beds. These beds provide food and protection for juvenile fishes and many invertebrates. In addition to the seagrass, several algal genera were also abundant, e.g., Dictyota, Padina, Halimeda and Avrainvillea species notably. The holothurians Holothuria atra and H. leucospilota, and the gastropod Trochus niloticus were also abundant.

The inner bay (Zone 5) was composed of alluvial silt and mud deposits, grading into a sand plane. The seagrass, Halophila minor, covered the floor in addition to the algal genera, Schizothrix, Avrainvillea and Halimeda.

No corals or macroinvertebrates were observed. The fish Zanclus cornutus was seen in large schools.

No threatened or endangered species are known for Ajayan Bay.

CONCLUSIONS AND RECOMMENDATIONS

Ajayan Bay provides the physiographic setting for a variety of community types. Though less strikingly beautiful than some other pristine areas, it is readily accessible and a popular place for fisherman, skin divers and picnickers. The fringing reef channels and seagrass beds are of particular importance for preservation.

The following recommendations are suggested for Ajayan Bay:

- 1) that this area be established as a natural sanctuary in which no coral harvesting be allowed.
- 2) that fishing be allowed only by special permit.
- 3) that swimming, snorkeling and SCUBA diving activities be retained.

- 4) that special care be taken to preserve the seagrass beds.
- 5) that the adjacent wetlands also be included in any preservation plan.

Table 36. Checklist of benthic algae observed at Ajayan Bay. Zones: east bay (I), west side channel wall and margin (II), reef flat (III), seagrass beds (IV), and mud-silt zone (V).

SPECIES	ZONES				
	I	II	III	IV	V
CYANOPHYTA (blue-green algae)					
<u>Anacystis</u> sp.	x				
<u>Microcoleus</u> <u>lyngbyaceus</u>	x	x		x	x
<u>Schizothrix</u> <u>calicicola</u>	x	x	x	x	x
<u>S. mexicana</u>	x	x			
CHLOROPHYTA (green algae)					
<u>Avrainvillea</u> <u>obscura</u>				x	x
<u>Boergesenia</u> <u>forbesii</u>			x		
<u>Boodlea</u> <u>composita</u>		x			
<u>Caulerpa</u> <u>filicoides</u>	x	x			
<u>C. racemosa</u>	x	x		x	
<u>C. serrulata</u>	x				
<u>Chlorodesmis</u> <u>fastigiata</u>	x	x			
<u>Codium</u> <u>edule</u>		x			
<u>Dictyosphaeria</u> <u>versluysii</u>	x	x	x		
<u>Halimeda</u> <u>gigas</u>		x			
<u>H. macroloba</u>					x
<u>H. opuntia</u>	x	x		x	
<u>H. velasquezii</u>		x			
<u>Neomeris</u> <u>annulata</u>	x	x		x	
<u>Rhipilia</u> <u>orientalis</u>	x				
<u>Tydemannia</u> <u>expeditionis</u>		x			
<u>Udotea</u> <u>argentea</u>	x	x			
<u>U. geppei</u>		x			
<u>Valonia</u> <u>ventricosa</u>		x			
PHAEOPHYTA (brown algae)					
<u>Dictyota</u> <u>bartayresii</u>		x			
<u>Dictyota</u> <u>divaricata</u>	x	x	x	x	
<u>Lobophora</u> <u>variegata</u>	x	x			
<u>Padina</u> <u>ionesii</u>	x				
<u>P. minor</u>		x			x
<u>P. tenuis</u>		x		x	x
<u>Sargassum</u> <u>polycystum</u>				x	
<u>Turbinaria</u> <u>ornata</u>	x	x	x	x	
RHODOPHYTA (red algae)					
<u>Actinotrichia</u> <u>fragilis</u>	x	x			
<u>Amphiroa</u> <u>foliacea</u>		x			

Table 36. (continued)

SPECIES	ZONES				
	I	II	III	IV	V
<u>Amphiroa fragilissima</u>		x			
<u>Amphiroa</u> sp.		x			
<u>Asparagopsis taxiformis</u>	xx				
<u>Ceramium</u> sp. 1	x	x			
<u>C.</u> sp. 2	x	x	x		
<u>Cheilosporum</u> sp.	x				
<u>Desmia hornemanni</u>		x			
<u>Galaxaura filamentosa</u>		x			
<u>G. oblongata</u>	x				
<u>Gelidium pusillum</u>			x		
<u>G. divaricatum</u>			x		
<u>Halymenia durvillaei</u>		x			
<u>Hydrolithon</u> sp.			x		
<u>Hypnea</u> sp.		x	x		
<u>Jania capillacea</u>			x	x	
<u>Mastophora rosea</u>		x	x		
<u>Polysiphonia</u> sp.		x	x		
<u>Porolithon onkodes</u>		x	x		

SPERMATOPHYTA (seagrasses)

<u>Enhalus acoroides</u>				xx	
<u>Halophila minor</u>				x	xx

Table 37. Checklist of corals observed at Ajayan Bay. Zones: east bay (I), west side channel wall and margin (II).

SPECIES	ZONES	
	I	II
ANTHOZOA		
ASTOCOENIIDAE		
<u>Stylocoeniella armata</u>		x
THAMNASTERIDAE		
<u>Psammocora contigua</u>		x
<u>P. nierstraszi</u>		x
<u>P. profundacella</u>		x
<u>P. verrilli</u>		x
<u>P. sp. 1</u>	x	
<u>P. sp. 2</u>	x	
POCILLOPORIDAE		
<u>Stylophora mordax</u>	x	x
<u>Pocillopora damicornis</u>	x	x
<u>P. danae</u>		x
<u>P. elegans</u>	x	x
<u>P. eydouxi</u>		x
<u>P. ligulata</u>		x
<u>P. meandrina</u>	x	x
<u>P. setchelli</u>		x
<u>P. verrucosa</u>		x
ACROPORIDAE		
<u>Acropora humilis</u>	x	x
<u>A. hystrix</u>		x
<u>A. kenti</u>		x
<u>A. nasuta</u>		x
<u>A. surculosa</u>		x
<u>A. wardii</u>		x
<u>Astreopora gracilis</u>		x
<u>A. listeri</u>		x
<u>Montipora ehrenbergii</u>		x
<u>M. elschneri</u>		x
<u>M. foveolata</u>		x
<u>M. lobulata</u>	x	x
<u>M. patula</u>		x
<u>M. socialis</u>		x
<u>M. tuberculosa</u>	x	x
<u>M. verrilli</u>		x
<u>M. sp. 1</u>		x
<u>M. sp. 2</u>		x
<u>M. sp. 3</u>		x
<u>M. sp. 4</u>	x	

Table 37. (continued)

SPECIES	ZONES	
	I	II
AGARICIIDAE		
<u>Pavona clavus</u>		x
<u>P. divaricata</u>		x
<u>P. frondifera</u>		x
<u>P. maldivensis</u>		x
<u>P. minuta</u>		x
<u>P. sp. 1</u>		x
<u>P. varians</u>		x
<u>P. repens</u>	x	x
<u>P. (P.) pollicata</u>		x
<u>P. (P.) obtusata</u>	x	x
PORITIDAE		
<u>Porites lobata</u>	x	x
<u>P. lutea</u>	x	x
<u>P. murrayensis</u>		x
<u>P. (S.) convexa</u>		x
<u>P. (S.) horizontalata</u>		x
<u>P. (S.) iwayamaensis</u>		x
<u>Alveopora sp.</u>		x
FAVIIDAE		
<u>Favia matthai</u>		x
<u>F. pallida</u>	x	x
<u>F. russelli</u>		x
<u>F. stelligera</u>		x
<u>F. sp.</u>	x	
<u>Favites virens</u>		x
<u>Plesiastrea versipora</u>		x
<u>Goniastrea parvistella</u>		x
<u>G. pectinata</u>		x
<u>G. retiformis</u>		x
<u>Platygyra pini</u>		x
<u>P. rustica</u>		x
<u>Leptoria phrygia</u>		x
<u>Hydnophora microconos</u>		x
<u>Leptastrea purpurea</u>		x
<u>L. transversa</u>		x
<u>L. sp.</u>		x
<u>Cyphastrea sp.</u>		x
OCULINIDAE		
<u>Galaxea fascicularis</u>		x

Table 37. (continued)

SPECIES	ZONES	
	I	II
MUSSIDAE		
<u>Lobophyllia costata</u>		x
<u>Acanthastrea echniata</u>		x
<u>A. sp.</u>		x
HELIOPORIDAE		
<u>Heliopora coerulea</u>	x	x
ALCYONIIDAE		
<u>Sinularia sp.</u>		x
HYDROZOA		
MILLEPORIDAE		
<u>Millepora dichotoma</u>		x
<u>Millepora platyphylla</u>	x	x

Table 38. Checklist of common macroinvertebrates observed at Ajayan Bay.

SPECIES

MOLLUSCA

GASTROPODA

Cantharus undosus
Cerithium morus
C. nodulosum
Conus pulicarius
Coralliophila violacea
Cypraea carneola
C. moneta
Drupa morum
D. ricinus
Drupella cornus
Latirus sp.
Morula granulata
M. uva
Nerita plicata
N. polita
Patella sp.
Strombus mutabilis
Thais tuberosa
Trochus niloticus
Vasum turbinellus

BIVALVIA

Pinctata margaritifera
Tridacna maxima

ECHINODERMATA

ECHINOIDEA

Echinostrephus aciculatus
Echinothrix calamaris
E. diadema

HOLOTHUROIDEA

Actinopyga mauritiana
Holothuria atra
H. leucospilota
Stichopus chloronotus
Synapta maculata

OPHIUROIDEA

Ophiocoma erinaceus

ARTHROPODA

CRUSTACEA

Etisus dentatus
Grapsus grapsus
Percnon sp.

Table 39. Checklist of fishes observed at Ajayan Bay.

SPECIES

ACANTHURIDAE

Acanthurus glaucoparietusA. lineatusA. nigrofususA. olivaceusA. pyroferusA. triostegusA. xanthopterusA. sp. 1A. sp. 2Ctenochaetus striatusC. sp.Naso lituratusN. sp.Zebrasoma flavescensZ. scopas

APOGONIDAE

Apogon sp.Archamia fucataCheilodipterus isostigmaC. macrodon

AULOSTOMIDAE

Aulostomus chinensis

BALISTIDAE

Balistes bursa (=Sufflamen bursa)Rhinecanthus aculeatus

BLENNIDAE

Aspidontus taeniatusCirripectes variolosusC. sp.Meiacanthus atrodorsalisPlagiotremus tapeinosoma

CANTHIGASTERIDAE

Canthigaster bennettiC. margaritatusC. solandriC. valentini

CARANGIDAE

Caranx melampygus

CHAETODONITIDAE

Chaetodon aurigaC. bennettiC. citrinellusC. ephippiumC. lunulaC. mertensiiC. melannotusC. ornatissimusC. punctato-fasciatusC. reticulatusC. trifasciatusC. ulietensisC. unimaculatusC. vagabundusCentropyge flavissimusHeniochus acuminatusH. chrysostomusPygoplites diacanthus

CIRRHITIDAE

Paracirrhites arcatus

GOBIIDAE

Acentrogobius sp. 1A. sp. 2Amblygobius albimaculatusBathygobius fuscusCryptocentrus sp.Ptereleotris microlepisTaenioides limicolaValenciennesa strigata"Goby" sp. 1"Goby" sp. 2

Table 39. (continued)

SPECIES

HOLOCENTRIDAE

Adioryx diadema
A. microstomus
A. spinifer
Myripristis sp. 1
M. sp. 2
M. sp. 3

KYPHOSIDAE

Kyphosus sp.

LABRIDAE

Cheilinus chlorourus
C. rhodochrous
C. trilobatus
Epibulus insidiator
Gomphosus varius
Halichoeres margaritaceus
H. marginatus
H. nebulosus
H. sp. 1
H. sp. 2
Labroides bicolor
L. dimidiatus
Stethojulis bandanensis
S. sp.
Thalassoma hardwickei
T. lutescens
T. quinquevittatus
T. trimaculatus

LETHRINIDAE

Gnathodentex aureolineatus

LUTJANIDAE

Aphareus furcatus
Lutjanus fulvus
L. kasmira
L. sp.

MONACANTHIDAE

Amanses carolae
Cantherhines pardalis
Oxymonacanthus longirostris

MULLIDAE

Mulloidichthys samoensis
Parupeneus bifasciatus
P. cyclostomus
P. pleurotaenia
P. trifasciatus

NEMIPTERIDAE

Scolopsis cancellatus

OSTRACIONTIDAE

Ostracion cubicus

PEMPHERIDAE

Pempheris oualensis

POMACENTRIDAE

Amblyglyphidodon curacao
Abudefduf coelestinus
A. sordidus
Amphiprion melanopus
Chromis atripectoralis
C. caeruleas
C. margaritifera
Dascyllus aruanus
D. trimaculatus
Glyphidodontops traceyi
Plectroglyphidodon dickii
P. johnstonianus
P. lacrymatus
P. leucozona
Pomacentrus vaiuli

Table 39. (continued)

SPECIES

Stegastes albifasciatus
S. nigricans

PRIACANTHIDAE

Priacanthus cruentatus

SCARIDAE

Scarus ghobban
S. sexvittatus
S. sordidus
S. sp. 1
S. sp. 2
S. sp. 3

SCORPAENIDAE

Pterois antennata
Synanceia verrucosa

SERRANIDAE

Cephalopholis urodelis

SIGANIDAE

Siganus argenteus
S. spinus

SYNODONTIDAE

Synodus sp.

TETRAODONTIDAE

Arothron sp.

ZANCLIDAE

Zanclus cornutus

AREA XI:
FADIAN POINT AREA

The northeast coast of Guam extending approximately 32 kilometers from Pago Bay to Pati Point is characterized by gentle to steep cliffs and sea-level cut benches of varying widths. There is no fringing reef development. Many of the benches are up to 30 meters in width exhibiting rimmed terrace pools (above sea-level) and shallow moat development to the shoreward side. A representative windward bench area was selected between Fadian and Toguan Points (Fig. 19). The area is remote and accessible only during calm seas either by "bench walking" or boat. The surrounding land is privately owned.

No previous survey has been done for this area with respect to the marine biotic community. An excellent physiographic description is given by Randall and Holloman (1974).

The Guam Environmental Protection Agency water rating for the Fadian Area is "A" - recreational. No point source discharges have been identified for the area (Shidel, 1977).

For purposes of this discussion, the study area was divided into four zones: (1) the inner bench including nips, moat and rimmed terrace pools, (2) the bench margin and face, (3) submarine terrace and slope, (4) submarine channel walls. Tables 40-43 list those organisms observed at the study site.

The inner bench was characterized by a concave nip to the shoreward side, a shallow moat 2-10 meters wide and a variable series of shallow rimmed terrace pools extending to the bench margin (Fig. 20). The rimmed terrace pools were approximately one meter higher than the depressed inner moat area. In general, the greater the wave assault, the greater the height and development of the rimmed pools. The moat water is generally impounded and dependent on sufficient wave action for replenishment.

The most dominant biotic component of this zone was the algae. The cyanophytes Calothrix and Schizothrix species covered much of the moat floor which was smooth and largely free of sand and rubble deposits. Gelidiella acerosa, Bryopsis pennata, Cladophora fascicularis and Turbinaria ornata were also abundant.

Due to frequent exposure, the bench was largely devoid of corals. A few small Pocillopora, Favia and Porites colonies were observed in the deeper holes and pools.

All fish observed in Zone 1 were less than 3 cm in length. Acanthurids and blennies were common in the moat and pool areas, occurring in water only 3-5 cm deep.

Figure 19. Eadien Point area exhibiting windward cut benches and rimmed terrace pools.

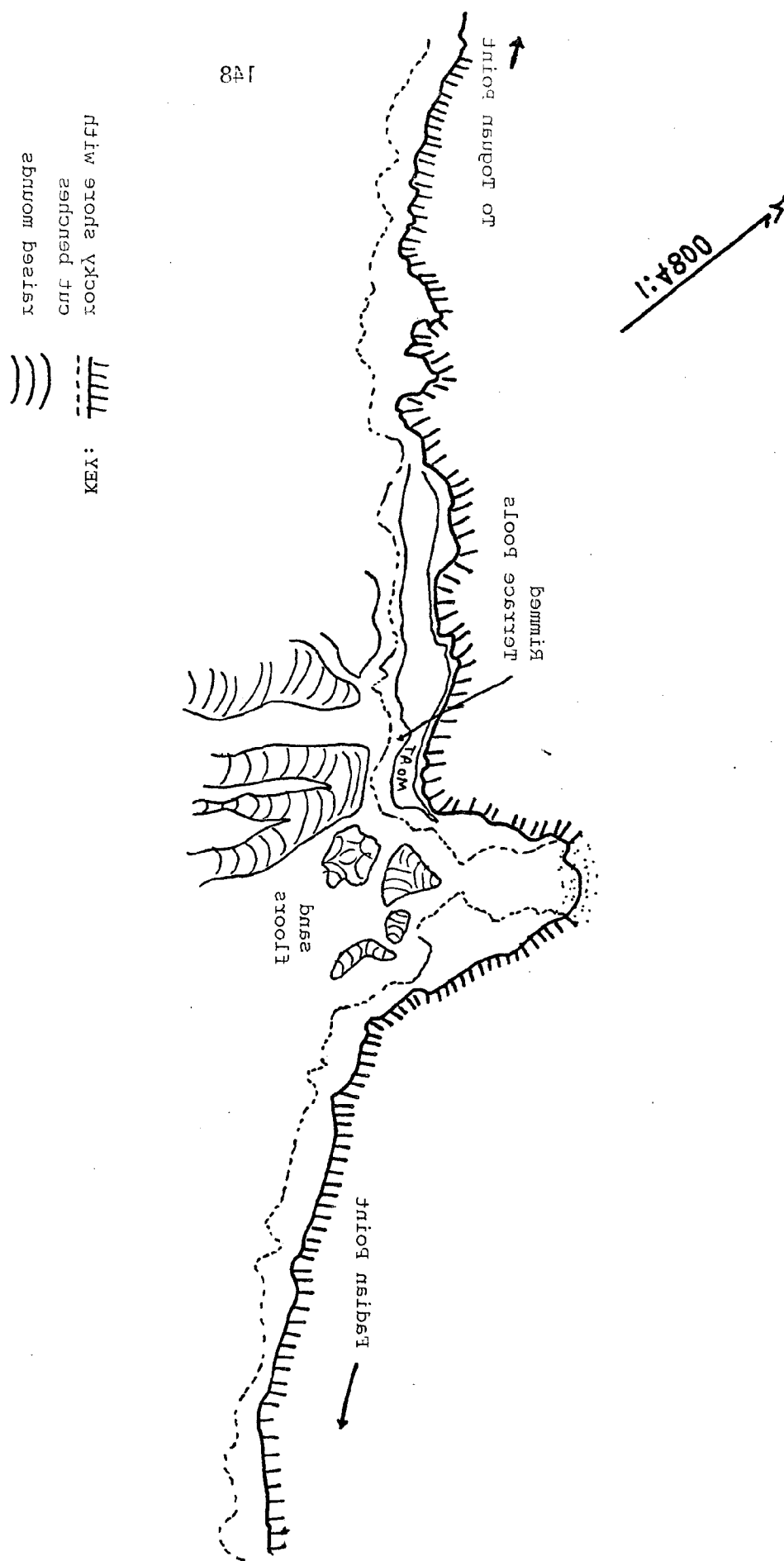
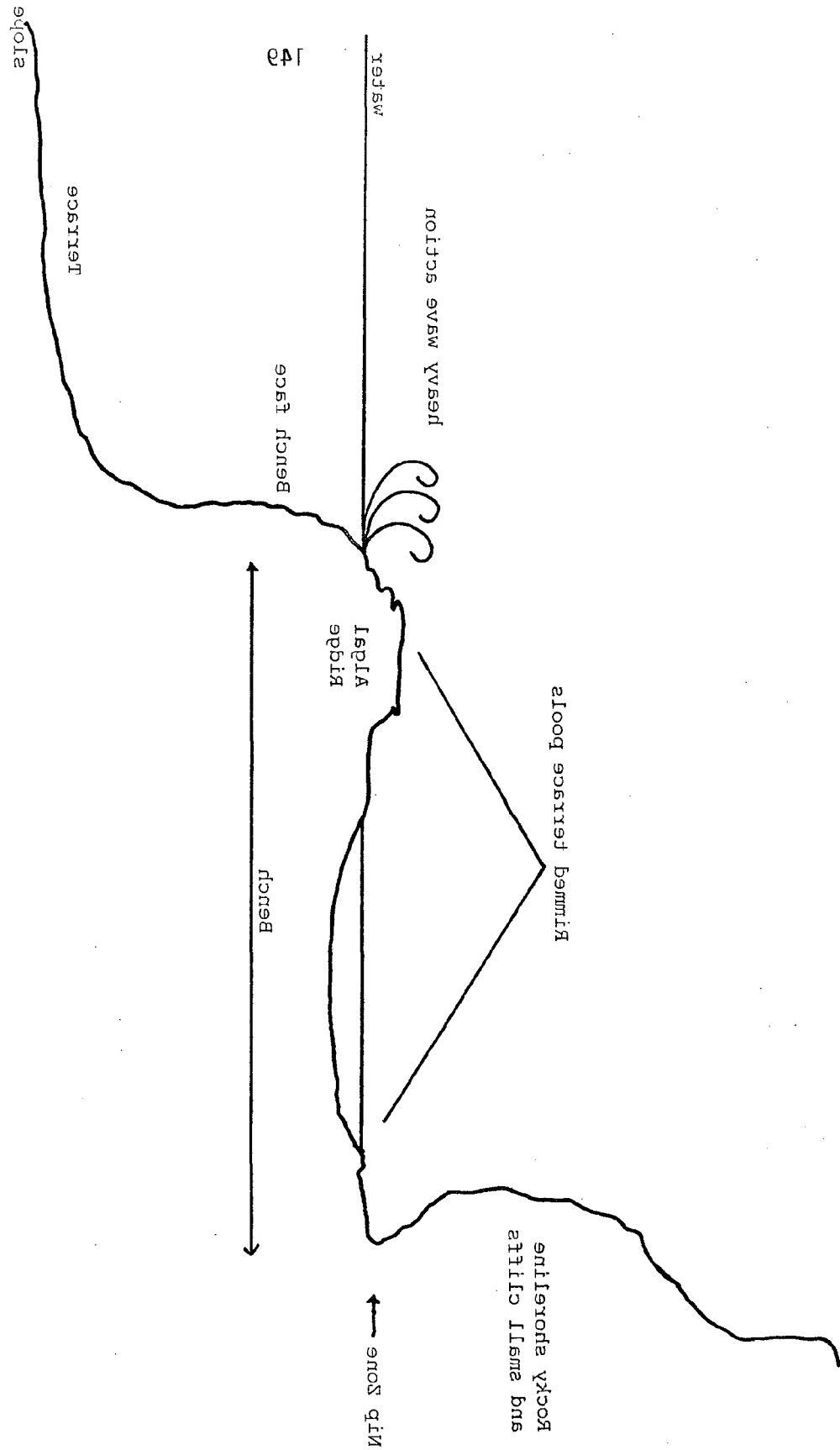


Figure 30. Generalized profile of typical windward cut benches and rimmed terrace boots.



An abundant, but not particularly diverse, array of gastropods were noted. A few echinoderms were also found in the moat and deeper pools.

The bench margin and face (Zone 2) are constantly wave washed. The bench margin was covered by a thick and colorful mat of algae giving way to a scoured and eroded margin face. Gelidiella acerosa, Dictyosphaeria, Ectocarpus, Sargassum, Turbinaria and Mastophora species were visually dominant on the margin while only Mastophora and Chlorodesmis were found in protected crevices along the margin face.

The submarine terrace and slope (Zone 3) consisted of massive surge channels and fissures grading into a spur and groove system at the bench face. Of particular interest was the presence of a parallel channel directly opposite the bench face with intersecting perpendicular projecting channels. These averaged approximately 5-7 meters deep shoreward and gradually flattened out at approximately 18 meters on the outer submarine terrace and slope.

The shoreward submarine terrace was scoured with only local patches of low relief corals, i.e., Acropora, Porites and Millepora species.

Turf algae dominated this zone. Callithamnion marshallensis and Ceramium sp. covered most of the terrace.

Seaward, the coral community improved with the presence of coral ridges and mounds. Porites, Acropora and Astreopora were abundant. A more diverse algal and fish community was also apparent.

The submarine channels (Zone 4) were markedly different from the surrounding surge exposed areas of the terrace. The algal community was particularly striking with fleshy forms visually dominating. Large expanses of the green alga Caulerpa racemosa several meters in diameter were not uncommon. The red algae Galaxaura, Halymenia and Desmia were also abundant. In addition, the red alga Yamadaella sp. was observed for the first time on Guam. This alga resembles a small Galaxaura.

Frondiose corals were abundant, providing an increased number of habitats for fish and invertebrates. Acanthurids and kyphosids dominated. In general this zone was rich but not terribly diverse with respect to fish. Only one species of pomacentrid was observed.

No threatened or endangered marine species are known to inhabit this area.

CONCLUSIONS AND RECOMMENDATIONS

The windward cut benches and rimmed terrace pools of northeast Guam provide the setting for several interesting marine community types. The Fadian area is a typical representative though any area along this sector is suitable. Heavy seas and poor accessibility throughout most of the

year preclude this area for recreational consideration.

The following recommendations are suggested for the Fadian area:

- 1) that this area be established as a natural sanctuary on scientific purposes only.
- 2) that care is taken to prevent the construction of out-falls or dumps in the area except by special permit.
- 3) that the area be protected from quarrying or any other destructive land use practices.

Table 40. Checklist of benthic algae observed at the Fadian Point area study site.

SPECIES	ZONES			
	I	II	III	IV
CYANOPHYTA (blue-green algae)				
<u>Anacystis</u> sp.	x			
<u>Calothrix</u> sp.	x	x		
<u>Microcoleus</u> <u>lyngbyaceus</u>			x	x
<u>Schizothrix</u> <u>calcicola</u>	x		x	x
<u>S. mexicana</u>	x		x	
CHLOROPHYTA (green algae)				
<u>Bryopsis</u> <u>pennata</u>	x			
<u>Caulerpa</u> <u>filicoides</u>	x			x
<u>C. racemosa</u>			x	xx
<u>Chlorodesmis</u> <u>fastigiata</u>			x	x
<u>Cladophora</u> <u>fascicularis</u>	x	x		
<u>Cladophora</u> sp.	x	x		
<u>Codium</u> <u>edule</u>				x
<u>Dictyosphaeria</u> <u>cavernosa</u>	x	x		
<u>D. versluysii</u>	x	x		
<u>Halimeda</u> <u>gigas</u>				x
<u>H. macroloba</u>	x		x	
<u>H. opuntia</u>	x		x	x
<u>H. velasquezii</u>				xx
<u>Neomeris</u> <u>annulata</u>	x		x	x
<u>Rhipilia</u> <u>orientalis</u>			x	x
<u>Udotea</u> <u>geppi</u>				x
PHAEOPHYTA (brown algae)				
<u>Dictyota</u> <u>divaricata</u>				x
<u>Ectocarpus</u> <u>breviarticulatus</u>	x			
<u>Lobophora</u> <u>variegata</u>			x	x
<u>Padina</u> <u>minor</u>			x	
<u>Sargassum</u> <u>cristaeifolium</u>	x			
<u>Sphacelaria</u> <u>tribuloides</u>	x			
<u>Turbinaria</u> <u>ornata</u>	x		x	
RHODOPHYTA (red algae)				
<u>Amphiroa</u> <u>foliacea</u>				x
<u>A. fragilissima</u>	x	x		
<u>A. sp.</u>		x		x
<u>Asparagopsis</u> <u>taxiformis</u>			x	
<u>Callithamnion</u> <u>marshallensis</u>			xx	x
<u>Ceramium</u> sp.				x

Table 40. (continued)

SPECIES	ZONES			
	I	II	III	IV
<u>Corallina</u> sp.				x
<u>Desmia hornemanni</u>				x
<u>Galaxaura marginata</u>			x	x
<u>G. oblongata</u>			x	x
<u>Gelidiella acerosa</u>	x	x		
<u>Gelidium pusillum</u>	x		x	x
<u>Halymenia durvillaei</u>				x
<u>Hypnea pannosa</u>				x
<u>Jania capillacea</u>	x			x
<u>Jania tenella</u>				x
<u>J. sp.</u>				x
<u>Liagora</u> sp.	x	x		
<u>Mastophora rosea</u>		x	x	x
<u>Mastophora</u> sp.		x	x	x
<u>Peyssonelia rubra</u>				x
<u>Polysiphonia</u> sp.			x	x
<u>Pterocladia parva</u>			x	x
<u>Rhodymenia</u> sp.				x
<u>Yamadaella</u> sp.			xx	xx

Table 41. Checklist of corals observed at the Fadian Point area study site.

SPECIES	ZONES		
	I	II	III-IV
ANTHOZOA			
ASTROCOENIIDAE			
<u>Stylocoeniella armata</u>		x	x
THAMNASTERIIDAE			
<u>Psammocora</u> sp.		x	
POCILLOPORIDAE			
<u>Stylophora mordax</u>		x	x
<u>Pocillopora verrucosa</u>		x	x
<u>P.</u> sp. 1	x		
<u>P.</u> sp. 2		x	
ACROPORIDAE			
<u>Acropora irregularis</u>			x
<u>A. nana</u>			x
<u>A. nasuta</u>			x
<u>A. palmerae</u>			x
<u>Astreopora</u> sp.			x
<u>Montipora ehrenbergii</u>			x
<u>M.</u> sp. 1			x
<u>M.</u> sp. 2			x
AGARICIIDAE			
<u>Pachyseris speciosa</u>			x
<u>Pavona</u> sp.			x
PORITIDAE			
<u>Alveropora</u> sp.			x
<u>Goniopora</u> sp.			x
<u>Porites lutea</u>	x		x
<u>P.</u> sp. 1	x		
FAVIIDAE			
<u>Favia russelli</u>	x	x	x
<u>Favis</u> sp.			x
<u>Goinastrea retiformis</u>	x		x

Table 41. (continued)

SPECIES	ZONES		
	I	II	III-IV
<u>Platygyra</u> sp.			x
<u>Cyphastrea</u> sp.			x
CARYOPHYLLIIDAE			
<u>Euphyllia</u> sp.			x
ZOANTHIDAE			
<u>Zoanthus</u> sp.			x
ALCYONIIDAE			
<u>Cladiella</u> <u>pachyclados</u>			x
<u>Lobophytum</u> <u>pauciflorum</u>			x
<u>Sinularia</u> sp.			x
HYDROZOA			
MILLEPORIDAE			
<u>Millepora</u> <u>platyphylla</u>			x

Table 42. Checklist of common macroinvertebrates observed at the Fadian Point area study site.

SPECIES	ZONES	
	I	III
MOLLUSCA		
GASTROPODA		
<u>Cerithium</u> sp.	x	
<u>Conus</u> <u>flavidus</u>	x	x
<u>C.</u> <u>marmoreus</u>	x	x
<u>C.</u> <u>rattus</u>	x	x
<u>Cypraea</u> sp.	x	
<u>Drupa</u> <u>morum</u>	x	x
<u>D.</u> <u>ricinus</u>	x	x
<u>Drupella</u> <u>cornus</u>		x
<u>Morula</u> <u>uva</u>		x
<u>Strombus</u> <u>mutabilis</u>	x	x
<u>S.</u> sp.		x
<u>Trochus</u> sp.		x
<u>Turbo</u> <u>argyrostomus</u>	x	
<u>Vasum</u> <u>turbinellum</u>	x	
BIVALVIA		
<u>Chama</u> sp.	x	
<u>Donax</u> sp.	x	
<u>Septifer</u> <u>bilocularis</u>	x	
<u>Tridacna</u> <u>maxima</u>		x
<u>T.</u> <u>squamosa</u>		x
ECHINODERMATA		
ECHINOIDEA		
<u>Echinometra</u> <u>mathaei</u>		x
<u>Echinometra</u> <u>oblonga</u>		x
<u>Echinothrix</u> <u>calamaris</u>	x	x
<u>E.</u> <u>diadema</u>	x	x
HOLOTHUROIDEA		
<u>Actinopyga</u> <u>mauritiana</u>	x	
<u>Holothuria</u> <u>atra</u>	x	
ARTHROPODA		
CRUSTACEA		
<u>Stenopus</u> <u>hispidus</u>	x	

Table 43. Checklist of fishes observed at the Fadian Point area study site.

SPECIES	ZONES		
	I	III	IV
ACANTHURIDAE			
<u>Acanthurus glaucopareius</u>		x	
<u>A. guttatus</u>	x		x
<u>A. lineatus</u>		x	x
<u>A. nigrofuscus</u>		x	
<u>A. olivaceus</u>		x	
<u>A. pyroferus</u>		x	
<u>A. triostegus</u>	x		x
<u>A. xanthopterus</u>		x	
<u>Ctenochaetus striatus</u>		x	
<u>Naso lituratus</u>		x	
<u>N. unicornis</u>		x	
APOGONIDAE			
<u>Cheilodipterus</u> sp.	x		
BLENNIDAE			
<u>Meiacanthus atrodorsalis</u>		x	
"Blenny" sp. 1	x		
"Blenny" sp. 2	x		
BALISTIDAE			
<u>Balistes bursa</u> (=Sufflamen bursa)		x	
<u>B. chrysopterus</u> (=S. chrysoptera)		x	
CANTHIGASTERIDAE			
<u>Canthigaster bennetti</u>		x	
<u>C. solandri</u>	x		x
CARANGIDAE			
<u>Caranx melampygus</u>		x	
CHAETODONTIDAE			
<u>Chaetodon auriga</u>		x	
<u>C. citrinellus</u>			x
<u>C. lunula</u>	x		x
<u>C. ornatissimus</u>		x	
<u>C. quadrimaculatus</u>		x	

Table 43. (continued)

SPECIES	ZONES		
	I	III	IV
<u>C. reticulatus</u>		x	
<u>C. trifasciatus</u>		x	
<u>C. ulietensis</u>		x	
<u>Forcipiger flavissimus</u>		x	
<u>Pomacanthus imperator</u>		x	
<u>Pygoplites diacanthus</u>		x	
CIRRHITIDAE			
<u>Paracirrhites forsteri</u>		x	
GOBIIDAE			
<u>Eviota</u> sp.	x		
HOLOCENTRIDAE			
<u>Adioryx spinifer</u>		x	
<u>Myripristis</u> sp.		x	
KYPHOSIDAE			
<u>Kyphosus</u> sp.			x
LABRIDAE			
<u>Bodianus axillaris</u>		x	
<u>Cheilinus rhodochrous</u>		x	
<u>C. trilobatus</u>		x	
<u>Coris gaimard</u>		x	
<u>Halichoeres hortulanus</u> (=H. <u>centriquadrus</u>)		x	x
<u>H. margaritaceus</u>		x	x
<u>Labroides dimidiatus</u>		x	
<u>Thalassoma lutea</u>		x	
<u>T. quinquevittata</u>		x	
<u>T.</u> sp.		x	
<u>Xyrichtys taeniourus</u>		x	
MULLIDAE			
<u>Parupeneus bifasciatus</u>		x	
<u>P. cyclostomus</u>		x	
<u>P. trifasciatus</u>		x	
NEMIPTERIDAE			
<u>Scolopsis cancellatus</u>			x

Table 43. (continued)

159

SPECIES	ZONES		
	I	III	IV
PEMPHERIDAE			
<u>Pempheris oualensis</u>		x	
POMACENTRIDAE			
<u>Glyphidodontops glaucus</u>	x		
<u>G. leucopomus</u>	x		x
<u>Plectroglyphidodon leucozona</u>		x	
<u>Pomacentrus vaiuli</u>		x	
POMADASYIDAE			
<u>Plectorhincus chaetodonoides</u>		x	
SCARIDAE			
<u>Scarus sordidus</u>		x	
<u>S. sp. 1</u>		x	
<u>S. sp. 2</u>		x	
SIGANIDAE			
<u>Siganus spinus</u>	x		x
ZANCLIDAE			
<u>Zanclus cornutus</u>		x	

AREA XII:
TARAGUE-SCOUT BEACH AREA

The north coast of Guam extending between Ritidian and Pati Points consists of intermittent long stretches of beach with a wide reef flat platform and convex algal ridge. The entire area lies within Andersen Air Force Base Military Reservation and, with the exception of a single military access road, the area is largely restricted to use by military dependents. Heavy surf and strong rip currents, especially near the larger surge channels, makes boat access and swimming dangerous most of the year.

A small section of East Tarague Beach, near Scout Beach was selected (Fig. 21). The area was chosen because of its well developed convex algal ridge and reef flat platform development, typical of northern Guam.

No previous study has been conducted for this area with respect to the marine biotic community. Randall and Holloman (1974) provide an excellent physiographic description. Portions of their report are incorporated below.

The reef flat platform consists of a poorly defined inner zone on which numerous scattered remnant patches of limestone occur. The middle consists mostly of a thin veneer of sand covering an irregular limestone platform. In many places columnar limestone projections (often a meter or more in height) protrude through this veneer. Much of the platform is exposed during low tide. Corals are restricted to the moat and depressed crevices that retain water. The margin consists of a well defined convex algal ridge and a massive spur and groove system, cut in places by large surge channels.

The Guam Environmental Protection Agency water rating for this pristine area is "AA" - conservation. No point source discharges are known in the immediate area.

The study site was divided into three zones: (1) inner reef flat and moat, (2) algal ridge, and (3) submarine terrace. Tables 44-47 lists those species observed during the study.

The cyanophytes Microcoleus and Schizothrix along with Ectocarpus, Lobophora and Turbinaria dominated the inner reef flat and moat.

The holothurians Holothuria atra and Actinopyga echinites were also abundant.

Corals and fish were limited to a few of the deeper pools and crevices in the moat.

The algal ridge (Zone 2) is of the convex type as opposed to a cuestas type observed at the Uruno-Ritidian area. In contrast to the depauperate conditions of Zone 1, Zone 2 was covered by a thick (5-10 cm) algal mat. Gelidiella acerosa, Acanthophora spicifera, Dictyosphaeria and Bryopsis species were dominant although numerous other genera were also observed.

The submarine terrace (Zone 3) was characterized by a massive spur and groove system grading into a more rolling topography. The coral community was predominantly low relief due to heavy wave action, but very dense. Pocillopora, Acropora, Montipora and Millepora species were all well represented. Deep sand channels bisected massive coral covered ridges.

The fish community was rich but not particularly diverse, while the algal community was characterized by large fleshy types including Halymenia, Galaxaura and Desmia species.

No threatened or endangered species have been identified for this area.

CONCLUSIONS AND RECOMMENDATIONS

The Tarague-Scout Beach area is a popular recreational spot for military dependents. A well developed convex algal ridge and channelized submarine terrace are typical of northern Guam. Although the reef flat itself is only sparsely populated in comparison to other pristine areas, the convex algal ridge more than compensates for this deficiency.

The following recommendations are suggested for the Tarague-Scout Beach area:

- 1) that this area be established as a natural sanctuary in which no coral harvesting, net fishing or other such activity be permitted.
- 2) that swimming, snorkeling and SCUBA diving activities be retained.

Table 44. Checklist of benthic algae observed at Tarague-Scout Beach area.

SPECIES	Terrace & Slope	Reef Flat	Margin (algal ridge)
CYANOPHYTA (blue-green algae)			
<u>Anacystis</u> sp.		x	
<u>Calothrix</u> sp.		x	x
<u>Microcoleus</u> <u>lyngbyaceus</u>	x	x	x
<u>Schizothrix</u> <u>calcicola</u>	x	x	
CHLOROPHYTA (green algae)			
<u>Boodlea</u> <u>composita</u>			x
<u>Bryopsis</u> <u>pennata</u>			xx
<u>Chlorodesmis</u> <u>fastigiata</u>	x	x	x
<u>Cladophora</u> <u>fascicularis</u>			x
<u>Dictyosphaeria</u> <u>versluysii</u>			xx
<u>Halimeda</u> <u>gigas</u>	x		
<u>H. opuntia</u>		x	
<u>H. velasquezii</u>	x		
<u>Neomeris</u> <u>annulata</u>	x		
PHAEOPHYTA (brown algae)			
<u>Dictyota</u> <u>bartayresii</u>	x		
<u>D. divaricata</u>	x		
<u>Ectocarpus</u> <u>breviarticulatus</u>			x
<u>Lobophora</u> <u>variegata</u>	x	x	
<u>Padina</u> <u>minor</u>	x	x	
<u>Sargassum</u> <u>cristaefolium</u>			x
<u>Turbinaria</u> <u>ornata</u>		x	x
RHODOPHYTA (red algae)			
<u>Actinotrichia</u> <u>fragilis</u>			x
<u>Acanthophora</u> <u>spicifera</u>		x	
<u>Ceramium</u> sp. 1			xx
<u>C. sp. 2</u>			x
<u>Corallina</u> sp.			x
<u>Desmia</u> <u>hornemanni</u>	x		
<u>Galaxaura</u> <u>marginata</u>	x		
<u>G. oblongata</u>	x		
<u>Gelidiella</u> <u>acerosa</u>	x		xxx
<u>Gelidiella</u> sp.			xx
<u>Gelidium</u> <u>divaricatum</u>	x		x
<u>G. pusillum</u>	x		x

Table 44. (continued)

SPECIES	Terrace & Slope	Reef Flat	Margin (algal ridge)
<u>Halymenia durvillaei</u>	x		
<u>Hypnea pannosa</u>	x		x
<u>Jania capillacea</u>		x	
<u>Jania tenella</u>		x	
<u>Mastophora</u> sp. 1	x	x	x
<u>Mastophora</u> sp. 2	x		x
<u>Pterocladia parva</u>	x		

Table 45. Checklist of corals observed at Tarague-Scout Beach study site.

SPECIES	Terrace & Slope	Reef Flat
ANTHOZOA		
POCILLOPORIDAE		
<u>Pocillopora damicornis</u>	x	x
<u>P. setchelli</u>	x	
<u>P. sp. 1</u>	x	
<u>P. sp. 2</u>		x
ACROPORIDAE		
<u>Acropora humilis</u>	x	
<u>A. nana</u>	x	
<u>A. nasuta</u>	x	
<u>A. palmerae</u>	x	
<u>A. sp. 1</u>	x	
<u>A. sp. 2</u>		x
<u>A. sp. 3</u>		x
<u>Montipora sp. 1</u>	x	x
<u>Montipora sp. 2</u>	x	
FAVIIDAE		
<u>Favia sp.</u>	x	
<u>Plesiastrea versipora</u>	x	
<u>Cyphastrea sp.</u>	x	
ZOANTHIDAE		
<u>Palythoa sp.</u>	x	
ALCYONIIDAE		
<u>Sinularia sp.</u>	x	
HYDROZOA		
MILLEPORIDAE		
<u>Millepora platyphylla</u>	x	x

Table 46. Checklist of common macroinvertebrates observed at Tarague-Scout Beach area.

Species	Terrace & Slope	Reef Flat
MOLLUSCA		
GASTROPODA		
<u>Cerithium morus</u>		x
<u>C. nodulosum</u>	x	x
<u>Conus chaldaeus</u>	x	x
<u>C. ebraeus</u>	x	
<u>C. sponsalis</u>	x	x
<u>Cypraea carneola</u>	x	
<u>Drupa clathrata</u>	x	
<u>D. morum</u>	x	
<u>D. ricinus</u>	x	
<u>Drupella cornus</u>	x	
<u>Lambis sp.</u>		x
<u>Patella sp.</u>	x	
<u>Thais tuberosa</u>	x	
<u>Trochus niloticus</u>	x	x
<u>Vasum turbinellus</u>	x	
BIVALVIA		
<u>Tridacna maxima</u>	x	
ECHINODERMATA		
ASTEROIDEA		
<u>Culcita novaeguineae</u>	x	x
<u>Linckia laevigata</u>		x
<u>L. multifora</u>	x	x
<u>L. pacifica</u>	x	x
ECHINOIDEA		
<u>Echinometra mathaei</u>	x	x
<u>Echinostrephus aciculatus</u>	x	x
HOLOTHUROIDEA		
<u>Actinopyga echinites</u>		x
<u>A. mauritiana</u>		x
<u>Bohadschia argus</u>		x
<u>Holothuria atra</u>		xx
<u>H. cinerascens</u>		x
<u>H. leucospilota</u>		x
<u>Stichopus chloronotus</u>	x	x
ARTHROPODA		
CRUSTACEA		
<u>Grapsus grapsus</u>		x

Table 47. Checklist of fishes observed along the terrace and slope zones at Tarague-Scout Beach area.

SPECIES

ACANTHURIDAE

Acanthurus glaucopareius
A. guttatus
A. lineatus
A. nigrofuscus
Ctenochaetus striatus
Naso brachycentron
N. lituratus
N. unicornis

BALISTIDAE

Rhinecanthus rectangulus

BLENNIIDAE

Cirripectes variolosus

CHAETODONTIDAE

Chaetodon quadrimaculatus
C. reticulatus
Pomacanthus imperator

CIRRHITIDAE

Cirrhitus pinbulatus
Paracirrhites forsteri
P. hemisticus

KYPHOSIDAE

Kyphosus sp.

LABRIDAE

Anampses caeruleopunctatus
Halichoeres marginatus
Labroides dimidiatus
Thalassoma amblycephalus
T. fuscum
T. quinquevittata

LUTJANIDAE

Lutjanus fulvus
Monotaxis grandoculis

MULLIDAE

Parupeneus bifasciatus

POMACENTRIDAE

Abudefduf saxatilis
Glyphidodontops leucopomus
Plectroglyphidodon dickii
P. leucozona
P. phoenixensis

SCARIDAE

Scarus sordidus
S. sp.

SUMMARY TABLE

Table 48. Summary of key information for selected pristine marine communities. Symbols: XXX = very diverse, XX = moderately diverse and X = fairly diverse.

	AREA	Principle physiographic features	Possible alternative sites	Fish	Algae	Corals	Invertebrates	GEPA	Pt. dis.	Special
I	Uruno-Ritidian	fringing reef with well developed cuetstal algal ridge.	further south along coastline	XX	XX	XX	XX	AA	-	-
II	Double Reef	patch reef and adjacent fringing reef	Anae patch reef	XXX	XX	XX	XX	AA	-	-
III	Haputo Beach	fringing reef	Double reef, plus any of the south bays	XXX	XXX	XX	X	AA	-	-
IV	Luminao	barrier reef	Cocos	XX	XX	XXX	XX	A	-	-
V	Sasa Bay and Atantano River mangroves	mangrove wetland area	Cocos	-	X	-	X	A	-	mangrove assoc. organisms
VI	Orote Submarine Cliffs	submarine cliffs	NONE	X	X	X	X	A	-	cryptic & deep water organisms
VII	Anae Island Patch Reef	patch reef	Double Reef	XX	XXX	XXX	XX	AA	-	extremely rich corals
VIII	Cetti Bay	estuary and fringing reef	Sella, Achugao, Fouha	XX	XX	XX	XX	AA	-	soft corals
IX	Cocos Area	estuary, fringing reef, barrier and patch reefs, barrier reef channels, mangroves, seagrass beds	NONE	XX	XXX	XXX	XXX	A	25+	unique area

Table 48. (continued)

	AREA	Principle Physiographic features	Possible alternative sites	Fish	Algae	Corals	Invertebrates	GEPA	Pt. dis.	Special
X	Ajayan Bay	fringing reef channel and seagrass beds	Ylig	XX	XXX	XX	XX	A	-	
XI	Fadian Point Area	windward cut benches with rimmed terrace pools	anywhere north to Pati Pt. or between Talofoto and Inarajan	XX	XX	XX	XX	A	-	
XII	Tarague-Scout Beach	windward fringing reef with well developed convex algal ridge.	anywhere between CE Beach and Ritidian Point	X	XX	X	X	AA	-	

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PLATE I

Fig. a. AREA I - Uruno/Ritidian Area showing an exposed cuestas algal ridge in the foreground.

Fig. b. AREA III - View of Haputo Beach and fringing reef from north rim.

Fig. c. AREA IV - Luminao Barrier Reef viewed from the western end of Glass Breakwater.

Fig. d. AREA V - East Sasa Bay mangroves.

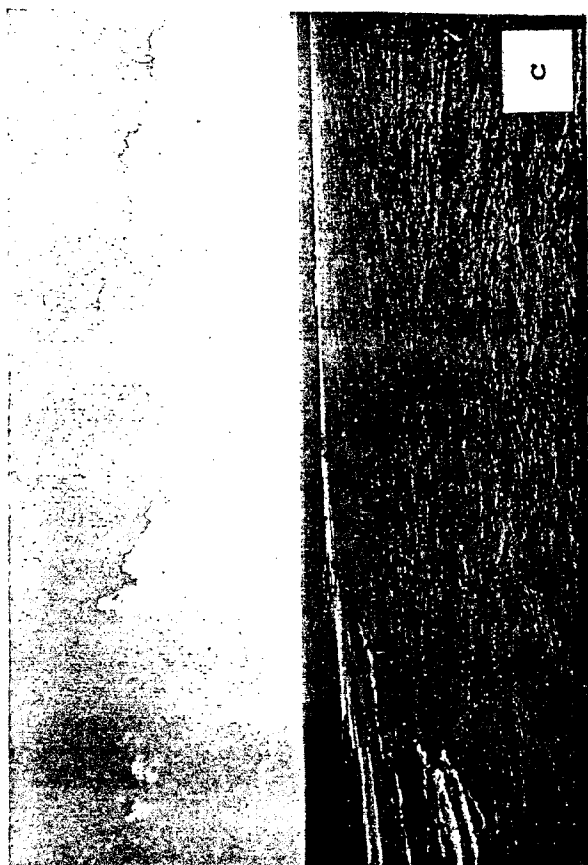
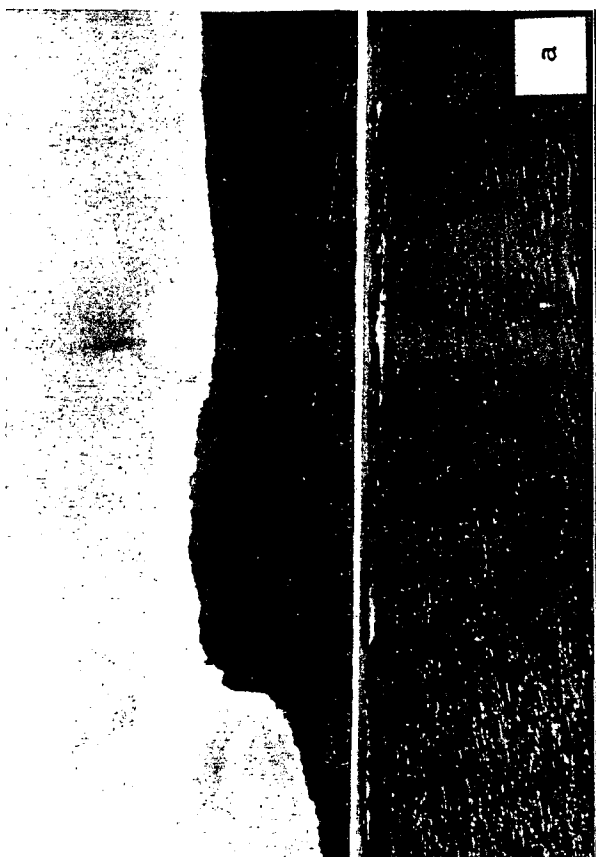
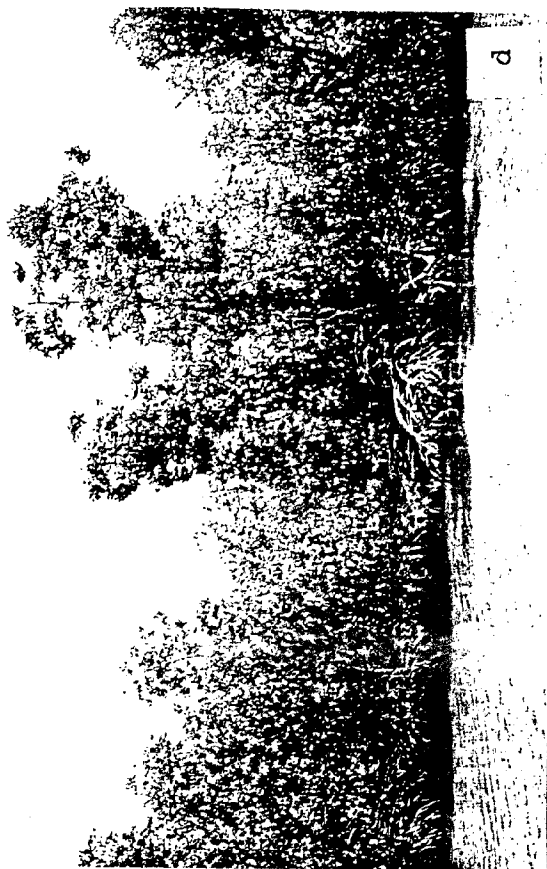


PLATE II

Fig. a. AREA VI - Orote Cliffs

Fig. b. AREA VII - Millepora species.

Fig. c. AREA VII - Massive ridges of Porites, typical of the
Anae area.

Fig. d. AREA VII - Porites pinnacle.

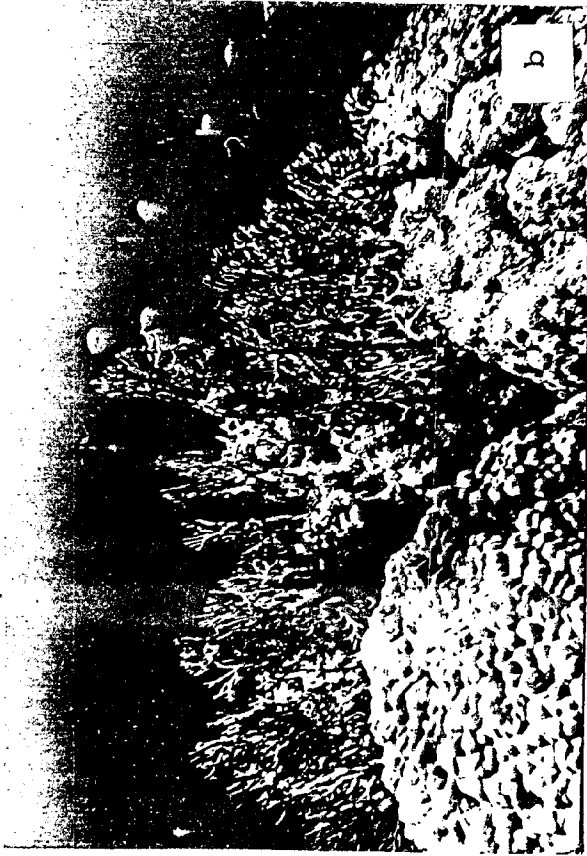


PLATE III

- Fig. a. AREA VIII - Cetti Bay viewed from Route 4.
- Fig. b. AREA VIII - Soft coral patch. Some of these areas were several meters square.
- Fig. c. AREA X - Exposed seagrass beds west of Agrigan Island, Ajayan Bay.
- Fig. d. AREA XI - Fadian Point Area cut benches.

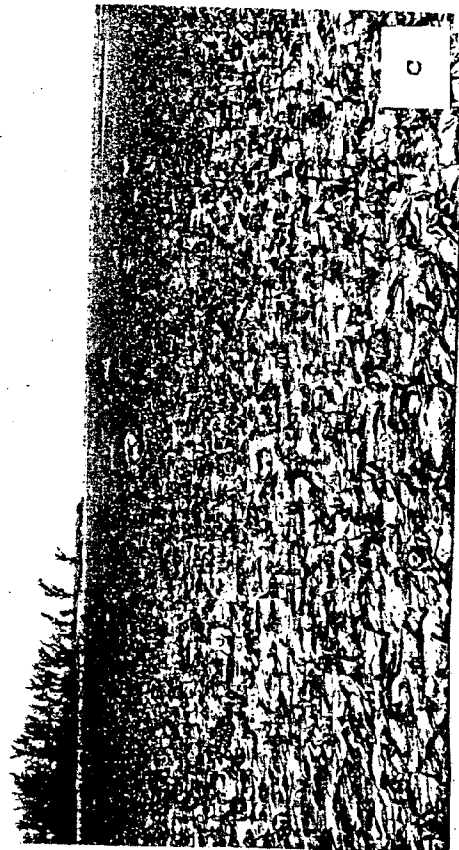
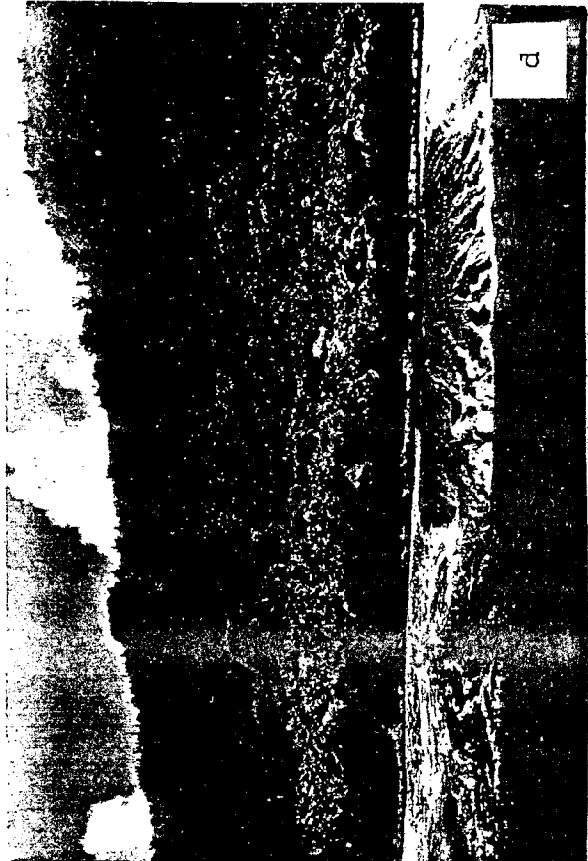


PLATE IV

Fig. a. AREA XI - Fadian Point Area cut benches and rimmed terrace pools showing moat.

Fig. b. AREA XI - Typical sand channel.

Fig. c. AREA XI - Close up of sand channel wall covered with the green alga Caulerpa racemosa.

Fig. d. AREA XII - Exposed convex algal ridge. The area shown is completely covered with the red alga Gelidium acerosa.

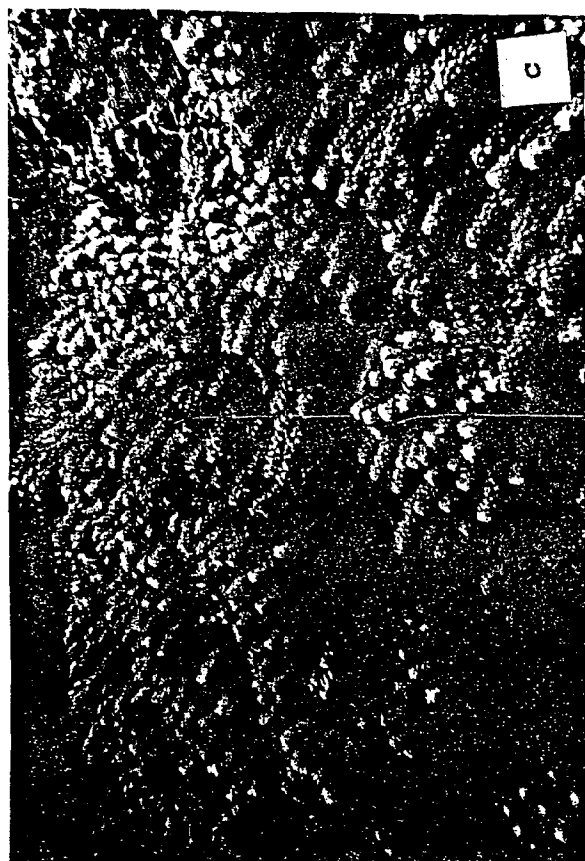
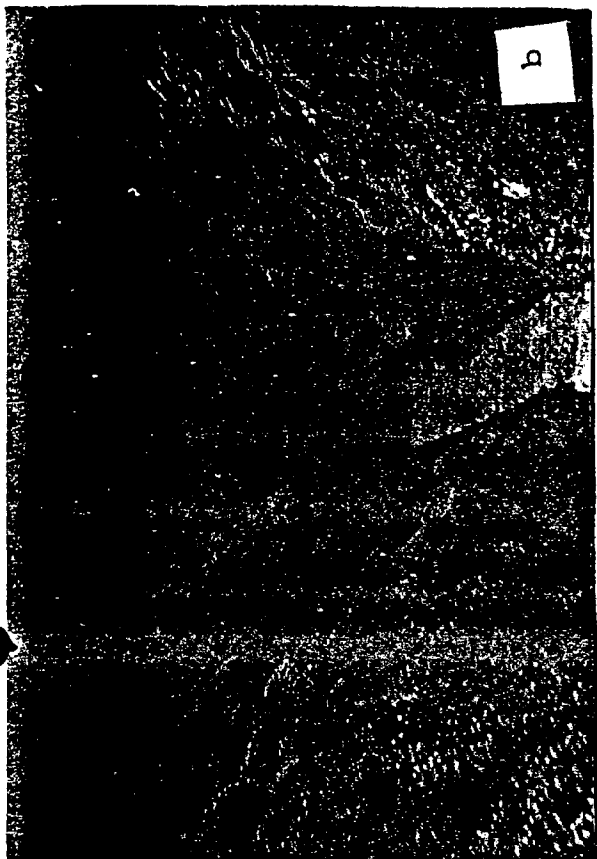


PLATE V

Fig. a. AREA IX - Aerial view of Cocos Barrier Reef. (Courtesy of
R. H. Randall)



